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BRIEFLY TOLD.

NOTES.—

AT the annual meeting of the Society of Gas Lighting, which was held in this city the second Thursday of the month, no change was made in the list of officers who direct its affairs. The Society continues to go on with its good work along the fraternal lines that marked its inception. A peculiarly graceful act at the annual meeting was the election to Honorary Membership of Mr. A. B. Slater, of Providence, R. I.

MR. EDMUND CATHELS has resigned the position of Manager of the Hamilton (Ont.) Gas Light Company, to accept the position of Engineer and Assistant Manager to the Providence (R. I.) Gas Company.

UNDER the franchise agreement between the authorities of Passaic, N. J., and the proprietors of the Paterson and Passaic Gas and Electric Company, the rate for gas in Passaic, on and after the 1st prox., will be $1 per 1,000 cubic feet.

THE formal transfer of the lighting plants formerly owned and operated in Holyoke, Mass., by the Holyoke Water Power Company, but which will hereafter be operated on public account, has been made. Mayor Chapin has appointed Mr. W. H. Snow Acting Manager of the Municipal Lighting Department, which is the official title of the bureau in control of the plants.

THE many friends of Mr. W. B. Keffer, the capable Secretary of the Capital City Gas Light Company, of Des Moines, Ia., will hail with pleasure the news that he is back at his desk in actual harness. His health is completely restored.

Dr. Birchmore Replies to Mr. Thos. Fletcher's "Criticism."

Messrs. Editors: No. 1,436 of your JOURNAL came to hand the rather late date of the 17th inst., and in reading it I found that you had reprinted an article from the London *Journal of Gas Lighting*, by Mr. Thos. Fletcher, the well-known stove maker, which might be mistaken by the casual reader for a criticism of my article on "The Heating of Inclosed Space," published October 12th last in your paper. Will you give me room for the following? At the same time that I ask you for space I want it distinctly understood that I do so only because you have reprinted Mr. Fletcher's criticism. Intrinsically it disturbs me little, for I well know that you would not have published an article such as this of Mr. Fletcher's is had I written such an one about a contribution to another paper. Understand, please, that my answer is not to Mr. Fletcher, but to the article which you publish. Without your publication I would not value it as much as I value this paper and ink, but your publication demands notice were the reply but to "John Doe," or to other like myths of the Jeromice type.

In regard to the manner of Mr. Fletcher's stricture (I decline to call it a criticism), I presume he admires it, yet to me it does not seem to follow the best possible models. It has too much, methinks, of spluttering anger and useless and meaningless verbiage; too much which is not only not germane, but quite beside the point at issue.

Respecting the matter, this "criticism" is dangerously near the line which critics, at least just critics, I have always noticed, seek to avoid. It seems to approach towards disingenuous statement and to lack but

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little of deliberate misrepresentation. If Mr. Fletcher had not been willing to cause his readers to think that I said so, why does he seek to make it appear that I was discussing a room in which were *seven* people, when I said only *three*. Next he says that hospital practice requires 500 cubic feet per hour. I said nothing of hospitals, nor did I say anything of a school room for 180 children, 7 or 8 years old. What I did say was that 50 cubic feet per hour per person was all that was required—that is, all that was absolutely necessary—in rooms used under the conditions I think sufficiently specified in my article, and this statement I repeat is quite correct.

Mr. Fletcher seeks to criticise my use of the word "assumed." He pretends not to understand it; perhaps pretends is too strong a word. He wishes, or seems to wish, his reader to think that he does not understand it. I wish that I could believe that he did not know how near this seems to be to more than embroiling the question. I cannot believe him ignorant of all that has been written during the past few years in regard to the amount of air actually needed for respiration. If he is thus uninformed I pity him, but if he is as well informed as the average reader of the New York city papers he must have seen that I had "assumed" 50 cubic feet as a more convenient factor to deal with than the average minimum need, 51.2874 cubic feet.

If there is a statement that the 50 cubic feet is to be renewed only once in 12 hours it is a pen slip, which I fail to find on rereading. Everything, context with statement, shows that the reference was per hour; more than that, I nowhere said 125 cubic feet, as he makes me say; but always 150 cubic feet. Yet had I missed this error in the proof any half-way intelligent reader would have seen that it was such; but in fact, I said 150 cubic feet, not 125 as Mr. Fletcher makes me say.

Lest any reader should need the assurance I repeat: "Experiments, many and most carefully made in every civilized land, and conducted independently by the most careful experts, show beyond all doubt that 50 cubic feet of air per hour exceeds the amount actually respired by any person not engaged in exercise." I had distinctly referred to an apartment in a private house, so why drag in hospitals and schools, why not jails as well, as if I had referred to them? Concerning the taste of such attempts to confuse the point at issue there can hardly be two opinions.

Mr. Fletcher states that the gas "In the United Kingdom" will vary 30 per cent. or more in its heat units. This has nothing to do with the case, but if true the gas in this country is a great deal more uniform than the gas in England. I certainly know of no gas which is so bad as to vary its heat content 3 per cent., much less 30 per cent. Will the English gas makers thank Mr. Fletcher for telling tales, I wonder.

Mr. Fletcher also says: "The loss of heat by walls and windows * * * has never been less than 75 per cent." But he forgets to mention 75 per cent. of what? Had Mr. Fletcher more experience as a scientific experimenter, and more sense of propriety in the use of his mother tongue, and the requisite knowledge and a willingness to accurately state the facts, he would separate "walls and windows" and express himself thus, "When the walls are constructed with a suitable air space, as the best architects require, the radiation loss by way of the walls may be reduced to 0.08 calories per square meter per hour; and with double windows the radiation loss by way of the window may be reduced to 0.03 calorie per square meter (say yard) per hour, per degree Centigrade of the difference in temperature between the air inside and outside." But perhaps they are as behindhand in building in England as the variation of 30 per cent. in heating power would imply that they are in gas making. Mr. Fletcher does not say if this variation is from day to day or from hour to hour—and it may be that Mr. Fletcher did not know the constant of radiation; yet it is hard to see how he could fail to have deduced it from the vast mass of data in reach.

I beg further to state that I made no mention of flues, up which Mr. Fletcher admits 75 per cent. of the heat of his stoves is lost. In this country such loss would keep a stove maker awake until he found some remedy.

Take it all-in-all, I believe that I would not be exaggerating if I said that Mr. Fletcher's article, from first to last, may be truthfully styled "Inaccurate in intention." He insinuates that my article contained statements which it did not contain, and he trades on the ignorance of his readers, because he well knew that my article had not been reprinted in the publication in which his appeared, and that hundreds of readers would see his pretended criticism who did not know, and in the nature of the case never would know, what I had written. So far as personal matter goes let me add this, Mr. Fletcher is a maker of gas stoves *with flues*. I am not a maker of stoves, but as I published for the use of whom it might concern a statement of what could be done by a stove *without* flues, with sufficient surface for heating the air, if the CO_2 of combustion were absorbed by damp Ca (2O H), it is no hard matter to understand the motive of Mr. Fletcher's unmannerly not to say unmanly personal attack. This closes the matter so far as I am concerned.

If any person wishes that I should explain and make clear anything in my paper, or clear up any statement unintentionally left obscure, my address is known. Let them write to me; no one who knows me will doubt that he will receive a full, civil, accurate and truthful answer to any rational question asked in good faith.

Dr. W. H. Birchmore.

341 Adelphi Street, Brooklyn, N. Y.

[Concluded from Page 870.]

The Future of Coal Gas and Allied Illuminants.—No. I.

[The first of a series of Cantor Lectures, delivered before the Society of Arts, London, England, by Prof. Vivian B. Lewes.]

Now, the facts with regard to water gas are these. Made by passing steam over incandescent coke or anthracite, it has an average composition of

Hydrogen	52
Carbon monoxide	38
Carbon dioxide	5
Oxygen	1
Nitrogen	4
	100

It is the 38 per cent. of carbon monoxide that has aroused the storm of angry criticism. Carbon monoxide, or carbonic oxide, the name by which it used to be more generally known, is a virulent poison, and when inhaled, in even small quantity, causes death by combining with the blood, and gradually cutting off the oxygen normally supplied to the body by the blood; 0.5 per cent. of carbon monoxide in the air will produce death if inhaled for over an hour, whilst 0.04 in the air will only cause headache and giddiness, however long the mixture may be inhaled, so that air containing more than 4 parts in 1,000 is fatally poisonous, and air containing less than 5 parts in 10,000 is practically harmless.

Now, this sounds alarming enough, and bears out the contentions of the opponents of water gas. But the points overlooked by them are that in an ordinary sized room it is very difficult to even purposely make a fatally poisonous mixture of air and the gas; and, secondly, that blue water gas, with its 38 per cent. of carbon monoxide, is not distributed as a domestic supply. In order to give luminosity, the otherwise non-luminous water gas is made to pass through chambers of heated chequer work into which a thin stream or spray of petroleum is injected, and the oil, being gasified by the hot brickwork into oil gas, mingles with the hot water gas, and the mixture, being fixed, that is, any oil remaining as vapor being converted into permanent gas, by passage through another heating chamber, the now highly illuminating mixture is known as "carburetted water gas."

The composition of the mixture will, of course, vary with the proportion of oil gas mixed with the water gas, but the quality most used for enriching coal gas is from 20 to 22-candle gas, and has the approximate composition of

Hydrogen	37.20
Saturated hydrocarbons	18.88
Unsaturated hydrocarbons	12.88
Carbon monoxide	28.26
Carbon dioxide	0.14
Oxygen	0.06
Nitrogen	2.64
	100.00

So that the dilution of the water gas by oil gas reduces the percentage of carbon monoxide to 28.2. But with the exception of a short period in one of the divisions of Liverpool, carburetted water gas alone has never been distributed in this country, although in America 296 of the largest companies send it out as a domestic supply.

In Great Britain it is almost entirely used to enrich and augment the supply of coal gas, and the amount added depends largely upon local circumstances. The following table shows the maximum and average percentages put into the coal gas in some of the more important towns:

Town.	Maximum.	Average.
Bath	40	10
Belfast	50	30
Birkenhead	64	36
Birmingham	24	..
Blackburn	33	..
Bridlington	..	25
Brighton	42.79	22.25
Colchester	20	..
Coventry	44	28
Hastings	33	..
Hornsey	36	..
Liverpool	50	..
London (north of the Thames)	20-25	..
Middlesbrough	33	..
Norwich	56	..
Preston	50	30
Southend	45	..
Southport	26	..
Swansea	25	..
Taunton	40	..
Tottenham	50	..
Winchester	30	..

Under ordinary conditions of working, therefore, it is safe to say that 20 to 50 per cent. of carburetted water gas is added to the coal gas supply. The whole question of what quantity shall be permitted hinges on the percentage of carbon monoxide present in the mixture. This should be kept down to a point that should prevent such small leakages as are possible in a dwelling room from being actively injurious or dangerous to life.

It must be remembered that coal gas itself contains a certain proportion of carbon monoxide, the quantity being dependent upon the composition of the coal and upon the conditions of temperature and exhaust in the retorts. It has been found that the presence of combined oxygen in coal gives rise during carbonization to the formation of oxides of carbon, and M. St. Claire-Deville, from a long series of experiments on 59 different kinds of coal, established the following relations:

Percentage of Oxygen in Coal.	Carbon Dioxide in Gas.	Carbon Monoxide in Gas.
5.0 to 6.5	1.47	6.68
6.5 to 7.5	1.58	7.19
7.5 to 9.0	1.72	8.21
9.0 to 11.0	2.79	9.86
11.0 to 12.0	3.13	11.93

The presence of the oxygen, also, in large percentage in the coal generally means a high yield of volatile hydrocarbons. Hence a gas of high illuminating power. But such coals are rather avoided by the gas manager, as they are high in price and ruin his coke. High retort temperatures also seem to have an effect in increasing the percentage of carbon monoxide, and in the analysis of gas by Mr. Lewis T. Wright, already quoted, it will be seen that whereas a Derbyshire caking coal yielded 8.72 per cent. of carbon monoxide when distilled at a dull red heat, the same coal yielded 13.96 per cent. of this gas at a bright orange heat.

A heavy exhaust would also tend in the same direction, as any trace of air leaking into the retort would form the monoxide. With the coals most used, however, from the Newcastle and Durham districts, the average percentage of carbon monoxide rarely exceeds 4 to 5.

It is now possible to gain an idea of the quantity that might with safety be allowed in the mixtures sent out as illuminating gas. There is no danger of poisoning by such mixtures during the daytime, as the smell of the gas attracts attention to the danger long before the gas reaches a serious proportion; nor is it of any use considering the cases of large leaks, as from broken mains or torn down fittings, as there would always be the risk of fatal results whether the gas was coal gas only or a mixture of coal gas and water gas. The real risk is during sleep, from such leakages as might be produced by leaky joints, or partly re-turning a loose tap when putting out the gas, and such a leak would practically never be a serious one, as if it were it would be detected before the occupant of the room could get to sleep.

My own view is that practical safety is assured as long as the percentage of carbon monoxide in the gas supply does not exceed 16 to 17. In the Departmental Committee's report they recommend "That the proportion of carbon monoxide in the public gas supply at night should be regulated to 12 per cent., or such greater amount as the Department may consider desirable;" and in the body of their report they say, "In some cases 12 per cent. of carbon monoxide in the gas supplied might be proper, in others 16 or perhaps 20. * * * With the present conditions of gas supply 20 per cent. is the highest proportion of carbon monoxide that should be allowed, and this percentage should be used only under special circumstances."

The views of the authorities in London are that the amount of carbon monoxide in the gas distributed should not exceed 16 per cent., and the Legislature is always so chary of doing anything to unnecessarily hamper a great industry, that the limit is not likely to be fixed below this point. Indeed, as coal gas *per se* may contain up to 12 per cent., fixing anything lower than 16 would be practically prohibiting the use of a valuable adjunct to gas manufacture. Taking, for the sake of calculation, the allowable limit as 16 per cent., this would mean that an ordinary coal gas containing 5 per cent. of carbon monoxide might have its bulk increased by carburetted water gas until the mixture contained 52 per cent. of coal gas and 48 per cent. of carburetted water gas, whilst if blue water gas were used, the limit would be reached when the mixture contained 66 per cent. of coal gas to 34 per cent. of blue water gas. In other words, to 100 volumes of coal gas you might add 92 of carburetted water gas or 51.5 of blue water gas before reaching the limit of 16 per cent. carbon monoxide in the mixture. The bearing of these figures will become apparent in a consideration of the factors that must govern the production of low grade gas.

The Future of Coal Gas and Allied Illuminants.—No. II.

[The second of a series of Cantor Lectures, delivered before the Society of Arts, London, England, by PROF. VIVIAN B. LEWES.]

In the last lecture I traced the changes that had taken place in the conditions of gas supply, and showed why an illuminating gas of comparatively low light giving power and good calorific value would be the need of the future. We can now proceed with the discussion of how this gas is to be best obtained; and, having gone into the question of what may be expected from high temperatures in carbonization, can proceed to consider the effect of blue water gas as an economical diluent, taking as a dominating factor that we must not add more than 40 to 43 volumes of blue water gas to 100 of coal gas, for fear of raising the percentage of carbon monoxide in the mixed gases above the advisable limit, and also because directly that amount is exceeded it begins to interfere with the action of atmospheric burners as adjusted for coal gas, and tends to cause flashing back.

The only successful processes used in Europe and America for the production of water gas have depended on the system introduced by Gillard in 1849, in which the temperature of a burning carbonaceous fuel, such as coke or anthracite, was raised to incandescence by means of an air blast, and then steam was passed through the incandescent fuel, with formation of water gas, until the temperature had been lowered to a point at which carbon dioxide began to appear in the gas to a serious extent, when the steam was cut off and the fuel again blown up to the required temperature by the air blast; the only differences in the systems adopted being in the form of plant and the arrangement of valves employed.

In all forms, however, up to 1895, but little attention was paid to the ratio existing between the air blast employed and the fuel in the generator. The result of urging the carbonaceous fuel to incandescence was to obtain a gaseous product, generally known as producer gas, the composition of which is:

Nitrogen	63.64
Carbon monoxide	29.33
Carbon dioxide	4.15
Hydrogen	2.88
	100.00

and which, under certain circumstances, can be used as a fuel gas, as it contains some 32 per cent. of combustible matter.

In order to raise the temperature of the fuel, however, to a sufficiently high point for the formation of 1,000 cubic feet of water gas by the passage of steam through it, 44 pounds of carbon had to be consumed during the blow, which yielded 4,000 cubic feet of producer gas. This, in the processes for making blue water gas, was blown to waste at the mouth of the generator, whilst another 15 pounds of carbon was consumed by the action of the steam in making 1,000 cubic feet of water gas itself; so that this amount of gas meant the consumption of about 60 pounds of carbon. The average yield of water gas per ton of coke by this process was 34,000 cubic feet, which represents only some 34 per cent. of the thermal value of the carbon from which it is formed; and it is quite clear that such a loss as this would prevent the use of water gas made by such a process being economical.

The plea put forward in favor of blue water gas as a fuel at this period was that you had the fuel in the form most easy of application, and that, also, by utilizing the producer gas as a fuel the heat to be obtained from it brought the total calorific value of the two mixtures up to 80 per cent. of the thermal value of the carbon used.

This argument, however, as regards thermal efficiency was purely fallacious in practice, as the two gases, being produced intermittently, would have to be stored in order to utilize them separately, and the enormous bulk of the producer gas as compared with its thermal efficiency would have required such an amount of storage room as to render such use of it impossible, whilst if stored, and therefore cold, it would have to be reheated before it could be got to burn, owing to the 68 per cent. of nitrogen and carbon dioxide diluting the combustible gases.

The introduction of carburetted water gas, however, provided a really successful method of utilizing the heat given off during combustion of the producer gas, as in the beautiful forms of apparatus devised for making carburetted water gas you really have a heat engine which does its work in a perfect way. During the blow the producer gas, red hot from the generator, is consumed with the requisite quantity of air in the checker-brick cracking and fixing chambers which are to decompose the oil and convert it into a permanent gas, and by the time the right degree of incandescence has been arrived at in the generator, the chambers de-

signed for the oil gas manufacture have also reached the required temperature, so that when the air blast is cut off and steam admitted to the incandescent coke in the generator, and a stream or spray of oil passed into the cracking chambers, you have at once a process for making carburetted water gas proceeding under the best conditions, as the hot water gas, sweeping forward through the cracking and fixing chambers, washes out from them the oil gas as it is produced, and saves it from over-decomposition by contact with the heated walls of the chambers, so that in reality, in all those forms of carburetted water gas apparatus which have arisen as improvements of Lowe's original ideas, you have the full thermal value of both the producer and water gas being utilized.

On the Continent, however, where the oil supply is not under such favorable conditions as in this country, an economical method of producing blue water gas still remained one of the greatest needs of the technical world, and it was in 1896 that Carl Dellwik gave a method of making water gas to the manufacturers which in simplicity and ease of working could not be surpassed, and which in one step did away with the production of the well-nigh useless producer gas, and doubled the production of water gas per ton of fuel. In the spring of 1897 I had the privilege of investigating this process at the little Westphalian town of Warstein, where Dellwik had the process installed. In June of that year I gave a lecture before the Incorporated Gas Institute, at their Bath meeting, in which I gave the results I had obtained whilst working with the apparatus; and at the present day I gather considerable amusement and pleasure from looking back to the criticisms and remarks which were aroused at that time. An American correspondent of mine took the trouble of writing to one of the leading gas experts in Germany asking for his opinion on the figures I had given. The reply received was that the results were absolutely impossible, and the writer was evidently not clear in his own mind as to whether I had been sufficiently intoxicated to have seen the results double, or was so incapable as not to be able to perform the experiments. I was, however, pleased to see a year later that the same gentleman had investigated the process himself and given identically the same figures; and he is now one of the most ardent supporters of the process.

In this process (which I have described already on more than one occasion, and which I need only now therefore touch upon), by careful regulation of the grate surface and the height of the fuel bed, and by careful regulation of the air blast, instead of bringing about incomplete combustion in the generator whilst blowing up to incandescence, and getting producer gas as a by-product, the ratios are so arranged as to give complete combustion and to yield practically ordinary flue gas during this process. This means that the carbon monoxide produced in the old process of blowing is now burnt in the generator itself, instead of in a supplementary chamber, as in the case of the Lowe process, and the extra temperature due to its combustion is given to the fuel, thereby raising it to incandescence in a much shorter time than had been required before, and so reducing the amount of fuel consumed. Burnt up by the excess of air during the blow, the carbon is converted into carbon dioxide and not carbon monoxide, so that instead of developing 2,400 pound-centigrade heat units per pound of carbon, it develops 8,080 for the same consumption, or an amount 3.37 times as great.

Having reached incandescence in this, the only rational and economical way, the fuel is then subjected to the action of steam. But the steam supply is so regulated that it is never at any time in excess of the quantity required for the formation of water gas. By this means oxidation of the carbon monoxide to carbon dioxide by steam, which always takes place to a small extent in the old process, is here avoided, and the result is that with a decent coke it is possible to produce 70,000 cubic feet of water gas per ton of carbon, as against 34,000 cubic feet with the old processes, a result which now makes water gas the most important factor in obtaining high temperatures. It is by this process that the blue water gas will have to be made in the future if it is to be successfully employed as an adjunct in the manufacture of an economical low grade gas.

Many experiments have been made with a view of seeing if the generators utilized for making water gas for the formation of carburetted water gas could be used on the Dellwik lines. It was soon found, however, that the alterations necessary cost far more than a new plant, and that an increase in the amount of air blast is by no means the only thing necessary to give the improved results, as unless this is accompanied by a careful regulation of the ratios between the fuel, grate area and air blast, but little improvement can be obtained. In America many attempts have been made to get away from the Dellwik patents by experiments in this direction, and I was pleased to hear the other day from one of the leading water gas makers in America that although he had blown his generators until, as he put it, the country round was an inch deep in ashes, he had absolutely failed to get any result approaching that given by the Dellwik plant.

Taking, now, our water gas made in the most economical way, we can proceed to see how it can be best used for diluting coal gas down to such standards as may hereafter be fixed upon. Mr. T. O. Paterson, in his inaugural address to the Incorporated Gas Institute last year, gave some most valuable figures on the relation of illuminating power and calorific value in gases, and tabulated the effect of diluting coal gas with uncarburetted water gas as follows:

Percentages		Illuminating Power.	Calorific Power. B.T.U.		B.T.U.'s per Candle.	
Coal Gas.	Water Gas.	Candles.	Gross.	Net.	Gross.	Net.
100	..	19.29	674.5	606.2	35.0	31.4
90	10	18.45	646.0	581.0	35.0	31.5
80	20	16.67	615.8	555.6	36.9	33.3
70	30	14.26	585.1	528.9	41.0	37.1
60	40	11.89	544.1	495.1	45.8	41.6
50	50	9.88	515.8	468.4	52.2	47.4
40	60	5.08	469.0	427.1	91.8	83.5
30	70	under 1.0	436.8	399.4	..	..
20	80	..	404.5	370.7	..	..
10	90	..	372.2	342.0	..	
..	100	..	333.0	306.8	..	..

It will be seen from this that the thermal value per candle of illumination becomes higher with considerable rapidity as the candle power of the gas is reduced. This manifestly must be so, as when the coal gas contains 70 per cent. of water gas the effect of dilution upon the hydrocarbons present is to render them non-luminous, whilst the net calorific value is still close on 400 B.T.U.'s.

The effect which the initial candle power of the gas has upon the effect produced by diluting it with blue water gas is of the greatest importance in considering the formation of our low grade gas, as it is manifest that in making a cheap gas one would never use coals of a quality which would give 19.29-candle coal gas. My first series of experiments in the direction of trying how best to make a low grade gas of satisfactory heating power was to try the effect of diluting coal gas of different calorific values with blue water gas, the gases being mixed *pro rata* as they flowed into the holder, and being allowed to stand overnight to complete the mixing.

In practice, if a 16 per cent. limit was fixed by Parliament for the carbon monoxide in the gas, it would be manifestly unwise to approach the limit too closely, as during a press of work, owing to fog or other causes, that threw a strain on the resources of the works a slight want of uniformity in mixing might bring the percentage above the limit. In these experiments 40 volumes of blue water gas were added to 100 of coal gas, which would give 28.5 per cent. of water gas in the mixture and bring the carbon monoxide up to about 14 per cent. The gases were measured through a meter before mixing, and the resulting mixture was tested for calorific value in a Junkers' calorimeter. The blue water gas used was purified from carbon dioxide, and had a calorific value of—

	Gross.	Net.
Calories per cubic foot	80.0	73.4
B.T.U.'s	320.0	293.6

The results obtained are shown in the following table:

Illuminating value of coal gas—				
Candles	17.6	16.0	15.3	15.1
Thermal value of coal gas—				
Calories, gross	172.0	159.9	158.8	149.9
" net	155.3	143.8	142.0	134.6
B.T.U.'s, gross	688.0	639.6	632.0	579.6
" net	621.2	575.2	568.0	538.4
Thermal value of mixture—				
Calories, gross	146.0	135.6	136.8	129.1
" net	131.7	122.8	123.2	116.7
B.T.U.'s, gross	584.0	542.4	547.2	516.4
" net	526.8	491.2	492.8	466.8
Percentage reduction in thermal value—				
Gross	15.1	15.2	13.4	13.9
Net	15.1	14.6	13.4	13.3

This table shows that, given an ordinary gas coal, such as we should in practice use, yielding 10,000 cubic feet per ton of a 15 to 16-candle power gas, it may have added to the 10,000 cubic feet 4,000 cubic feet of blue water gas, with a reduction of only 13 to 15 per cent. in thermal value. The experiments made by Mr. Paterson and others show that the reduction in candle power is practically proportional to the volume of water gas added, as one would expect, so that the candle feet per ton of coal carbonized would be practically the same whether they were present in 10,000 cubic feet of coal gas or 14,000 cubic feet of the mixture.

Instead, however, of mixing the blue water gas with the cold coal gas, a distinct advantage is to be gained by passing the gas into the foul main. This is done at several places in Germany, notably at Erfurt, and it is found that a distinct gain in candle power is obtained, owing to the water gas becoming to a slight extent carburetted with benzol vapor present in the hot gas, which, if allowed to cool, would be taken up by the tar. I regret to say that I have no direct figures which show the result of percentage admixtures made in this way of blue gas and coal gas, as in all the works where it is used the mixed gases are benzolized —*i. e.*, enriched to a small extent by benzol before being sent out. The saving is found by less benzol being required to bring the gas up to a given candle power when the mixture is made in this way than when, as is done in some other places, the water gas is enriched with benzol and is then afterwards mixed in with the coal gas.

In utilizing water gas for the dilution of coal gas it is possible, however, to make it perform a far more important function than that of merely increasing the volume. One of the weakest points in the manufacture of coal gas is to be found in the process of carbonization, which has undergone little or no change since the earliest days of the gas industry. When the coal is placed in the hot retort, evolution of gas at once commences with great rapidity, and working with a 5 hours' charge, the largest proportion and the richest portion of the coal gas is evolved during the first 3 hours. The general course of the reactions are well shown in the following table of results found by Mr. Lewis T. Wright in his studies on carbonization:

Time of Observation, Seconds.	Percentage of Total Gas Evolved.	Average Retort Temperature, Deg. F.	Candle Power per 5 Cubic Feet.
30	12.3	1,108	21.8
60	26.1	1,212	20.2
90	38.9	1,200	17.7
120	52.6	1,292	14.8
150	65.8	1,315	13.5
180	78.6	1,360	11.7
210	85.5	1,435	10.7
240	92.6	1,531	7.1
270	96.4	1,613	5.1
300	100.0	1,671	3.8

A moment's consideration of the actions taking place during carbonization shows that whereas in order to obtain the best results the coal gas during retorting ought to remain under absolutely uniform and reliable conditions of temperature and time of exposure to the heat of the retort, yet these are the very factors which it is absolutely impossible to obtain under existing circumstances. The gas and vapors generated from the coal at the mouth end of the retort have only a very short exposure to radiant heat from the walls of the retort, as they are hurried out by the volume of gas behind them, and therefore leave almost unacted upon by the heat, whilst the gas from the extreme end of the retort, having nothing to urge it forward, gets largely decomposed by overheating; with the result that not only are many of the heavy hydrocarbons, which would have been of the greatest value as illuminants to the gas, broken down into methane, hydrogen and carbon, but also the overbaking yields a large percentage of the naphthaline found in the tar and mains.

It has always been a dream of the gas manager to devise some process which would enable him to decompose the tar formed during destructive distillation, and, by getting from it hydrocarbons of high illuminating value, to do away with enrichment by other and more costly processes. Many attempts have been made in this direction, but, so far, the only way in which tar has shown itself of value as an enricher has been to separate from it the benzol and then return that benzol to the gas in the carburetor. I have many times pointed out that when once formed tar is one of the most difficult bodies to again decompose. Its formation is due to two distinct sets of actions—a primary action in which liquid hydrocarbons distil as vapors from the less heated portions of the coal in the retort, and, escaping decomposition by the radiant heat from the crown of the retort, condense as liquids again on cooling; whilst a secondary reaction is of a synthetic character, and results in the formation of naphthaline, carbon and many of the heavier constituents of the tar, by the polymerizations and decompositions taking place in the heated crown of the retort at the expense of hydrocarbon gases which ought to find their way unaltered into the gas. I have also pointed out that the only rational method of getting the benefit of the hydrocarbons which are at present lost as tar is to prevent their conversion into that body.

In a lecture I gave before the Incorporated Institution of Gas Engineers in 1900 I suggested that instead of using water gas merely as a diluent it should be made a factor in the distillation itself. I then proposed that a stream of water gas should be passed through the crown of the retort during the process of carbonization, so as not only to hurry the newly born hydrocarbon gases out of contact with the hot walls of the retort, but also, by diluting them, to prevent the secondary reactions, which are so important a factor in the production of tar, taking place, and by so doing to save many of the important lighting and heating constituents from destruction. Through the kindness of Sir George Livesey and Mr. S. Y. Shoubridge experiments were shortly afterwards made at the Crystal Palace District gas works, which gave results which pointed to this method of utilizing water gas being of the greatest possible importance to the future of coal gas.

In these experiments a Derbyshire coal was employed, and the yield of gas and candle power given by the coal were tested on a large scale before, during, and after the water gas experiments. It was found that under ordinary conditions of carbonization the coal yielded 10,468 cubic feet per ton of 15.88-candle power gas. The plant used in the earlier experiment consisted of 6 beds of 7 retorts each, and, later, of 12 beds 7 retorts. The section of all retorts was 22 inches by 16 inches, and 20 feet long, heated by regenerative furnaces and charged by power stoking machinery. The gas from them was passed through one complete section of the works separately, and was therefore condensed, scrubbed, purified, and measured in the usual way—the ordinary gas manufacture being carried on at the time in other sections of the works.

The water gas was made in the ordinary "Economical" water gas plant, and conveyed from the relief holder to the retort house by a special pipe. This pipe was continued over the retort bench, just above the arch pipes on one side, and a connection was made from it to the top of each ascension pipe on that side of the bench. Each connection was fitted with a cock having a lever handle with rod attached to it, so that the cock could be regulated from the charging floor. The dip pipes on this side were blocked and the hydraulic main valves closed. The water gas therefore descended the ascension pipes on this side, passed through the retort, and up the ascension pipes on the other side, along with the coal gas.

The quantity of water gas which could be passed through each cock, when partly and when full open, was ascertained before the test by measurement through a meter. This enabled an approximate measurement of the quantity of water gas put into each retort to be made. But the actual quantity used in each experiment was checked by noting the quantity taken out of the holder. The heat of the retorts was maintained as nearly uniform as possible throughout the tests, and at as high a temperature as is used in ordinary working.

Many experiments were made in this way, all of which showed that important economies could be attained by the process. The following will give an idea of the result obtained by using 40 per cent. of blue water gas in this way as compared with 40 per cent. simply mixed with the coal gas.

Coal carbonized	82	tons.
Make of gas per ton	13,730	cubic feet.
Water gas added per ton	4,005	"
Proportion water gas added	41.1	per cent.
" " " in mixture	29.1	"
Candle power	14.87	
Standard $\frac{10,468 \times 15.88}{5}$ =	32,446	
Candle feet $\frac{13,730 \times 14.87}{5}$ =	40,833	
Gain in candle feet on standard	25	per cent.

Analysis of Gas.

	I.	II.
Hydrogen	50.37	50.62
Saturated hydrocarbons	29.24	29.49
Unsaturated hydrocarbons	2.98	2.48
Carbon dioxide	0.49	0.49
Carbon monoxide	14.92	14.92
Oxygen	nil	nil
Nitrogen	2.00	2.00
	100.00	100.00

Calorific Value.

Calories	149.8 gross.	132.9 net.
B.T.U.	599.2 "	531.6 "

These experiments were renewed in 1901 with inclined retorts instead of horizontal, and a bench of 70 inclined retorts which had been newly erected was utilized for the purpose. The water gas was made, as in the previous experiments, in the generator of the "Economical" plant usually employed for the manufacture of carburetted water gas. The gas was passed into a holder of 469,800 cubic feet capacity, and thence was carried to the inclined retorts, into which it entered at atmospheric

temperature. The gas was not purified before being admitted to the retorts, but was tested for carbon dioxide, of which it contained from 5 to 6 per cent.

The carbon dioxide, after estimation, was deducted by calculation from the volume of water gas used, because the volume of mixed gas produced was measured in station meters after the whole of the carbon dioxide had been removed by purification in the usual manner. To ascertain whether the carbon dioxide in the water gas was converted into carbon monoxide by passage through the retorts, the mixed gas was examined at the inlet to the washers and found to contain 3 per cent. of carbon dioxide.

It may, therefore, be assumed that the carbon dioxide, as it passed through the retorts, was not converted to any appreciable extent into carbon monoxide.

No station meter could be placed at my disposal for the measurement of the water gas. The holder of known capacity (469,800 cubic feet) was therefore filled before the commencement of each experiment, no gas being admitted to the holder during any trial. The volume of the gas was obtained by recording the height of the holder at the commencement and completion of the experiment, and making all the necessary corrections for temperature and pressure. The quantity of water gas used during 24 hours varied in the different experiments from 200,000 to 370,000 cubic feet. The gas leaving the retorts was purified in the usual manner, and then passed through station meters, from which readings were made every hour.

During every hour the gas was slowly by-passed into a small holder, from which gas was drawn at the completion of each hour for the determination of the illuminating power by means of the Referees' table photometer, and from which once every day gas was drawn for analysis and for the determination of its calorific power by means of a Jünkers' calorimeter.

The coal used in the experiments was the same kind of Derbyshire coal as had been used in the previous tests, but of slightly inferior quality.

Before commencing the experiments with water gas, a trial run was made for 7 days with the coal alone, the tests being made every hour, day and night, so as to obtain a standard for comparison. The principal results obtained were:

Total coal carbonized.....	603 tons.
Total gas made, corrected...	5,973,682 cubic feet.
Make per ton.....	9,907 " "
Average illuminating power (table photometer).....	16.55 candles.
Total tar (hydraulic).....	5,060 gallons.
Tar per ton.....	8.3 "
Calorific power, gross.....	152.6 calories per cubic foot.
" " net.....	138.8 " " " "

These figures give the value of 32,792-candle feet per ton for the coal, and this figure is taken as the standard in the following experiments.

In arranging the apparatus for the experiments, the upper mouthpiece of each retort was fitted with a pipe and stopcock for the admission of the water gas. These experiments were continued from 19th June to 23d August, 1901. Passage of water gas in varying proportions through the retorts was tried, and also the influence of the period of carbonization at which the flow of diluting gas was started. It was found that although the results obtained were far better than in the experiments made with the horizontal retorts, they were of the same kind, and that the gain in candle feet per ton gradually rose with increase in the volume of water gas used, reaching a maximum with about 40 volumes of water gas per 100 of coal gas, and decreasing when this point was passed.

Water Gas Added Per Cent. of Coal Gas.	Candle Feet per Ton of Coal.	Percentage Gain in Candle Feet Per Ton of Coal.
21.9	37,582	14.6
25.5	38,235	16.6
27.8	41,343	26.0
37.6	40,936	24.8
40.1	43,703	33.2
42.0	42,984	31.0
45.6	40,467	23.4

The most important data with regard to these experiments were given in a table at the end of a paper read before the International Engineering Congress at Glasgow last year, but the results are so extraordinary and so full of interest that it is as well to give the full data for two experiments, in which 40 and 42 per cent. of water gas respectively were added, as they give a better idea of the scale of the experiment.

	I.	II.
Coal used.....	85.4 tons.	88
Total make (corrected).....	1,274,656 cubic feet.	1,294,946
Make per ton.....	14,925 "	14,715
Illuminating power (table photometer).	14.4 candles	14.85
Total tar (hydraulic)	690 gallons	651
Tar per ton	8.07 "	7.4
Water gas added	42.0 per cent.	40.1
Water gas in mixture.....	29.5 "	28.6
Water gas per ton of coal carbonized..	4,415 cubic feet	4,215
Candle feet per ton $\frac{14,925 \times 14.4}{5}$ = ..	42,984 $\frac{14,715 \times 14.85}{5}$ =	43,703
Standard for coal carbonized alone....	32,792	32,792
Increase in candle feet on standard...	31.07 per cent.	33.2

Calorific Value.

	Gross.	Net.	Gross.	Net.
Calories.....	127.2	116.8	125.8	118.7
B.T.U.....	506.8	467.2	503.2	474.6
Carbon monoxide present in purified gas.	14.0 per cent.		15.2 per cent.	
Gain in calorific value.....	25.5 "		22.4 "	

So that a gain of 31 to 33 per cent. in candle feet and 22 to 25 per cent. in total calorific value is attained.

One point which should be clearly borne in mind when using water gas to clear the hydrocarbon compounds out of the retort is that cold water gas will have a cooling effect upon the crown of the retort and upon the gases evolved by the coal. Every gas manager knows to his cost that unless the temperature in the ascension pipe rises above 470° to 490° F. he runs great risk of choked ascension pipes, and although the admixture of water gas reduces, and indeed does away with stoppages, owing to alteration in the character of the tar and to dilution, yet the cooling of the gas, if carried to extremes, is quite capable of bringing about the very trouble that the process, when properly applied, would entirely prevent. This is one reason why hot water gas should be employed in preference to cold. If, however, the conditions are such that the use of hot water gas is an impossibility, then the passage of the diluting gas should not be carried on for too long. Mr. Foulis has shown that the temperature of the gases in the ascension pipe at a distance of 18 inches from the mouthpiece averages 890° F. (476° C.) shortly after the charge is introduced, and falls to 518° F. (287° C.) towards the end of the charge. It is evident from this that to maintain a temperature of not less than, say, 500° F. (277° C.) 18 inches above the mouthpiece, a very large proportion of water gas may be used during the first 2 hours of distillation. The water gas should then either be reduced or or cut of; the latter being the course most likely to be adopted in practice.

During carbonization the large volume of gas which is evolved in the earlier periods of the charge is that which contains the highest proportion of rich hydrocarbons, and these are the compounds, not only of highest illuminating value, but the ones most liable to be broken down into less valuable illuminating bodies by undue heating, whilst the gases evolved in the later stages of carbonization are of low illuminating power and will withstand a higher temperature. This falling off in the quality of the gas during carbonization is partly due to decrease in the quantity of gas evolved, which leaves the gas exposed too long to the action of the heated walls of the retort, and still more to the fact that as the heat in the retort acts upon the charge of coal it is the large outer surface which is first affected, the bottom of the charge by direct contact with the retort and the upper portions by radiation from the walls. Messrs. Folkard and Heisch showed that with 6-hour charges only one-sixth of the coal remained uncarbonized at the end of the third hour. This remained as a core in the charge, surrounded by a crust of 3 inches of coke; and as the coke would be at a temperature not very far below that of the retort, the heavy hydrocarbons evolved during the last period of the carbonization would be so degraded by filtering through the heated crust that the water gas would have but little chance of showing any profitable influence.

That this is so is indicated by the fact that in experiments made with cold water gas introduced an hour after carbonization had started, and carried on for 3 hours, *i. e.*, until 4 hours of carbonization had elapsed, a gain of only 16 per cent. in candle feet was obtained, whilst when the water gas was admitted directly after the charge and was continued for 3 hours, a gain of 33 per cent. in candle feet showed itself.

[To be Continued.]

Blast Furnace Gas Engines and Their Work.—No. II,[1]

Let me begin a discussion of individual designs with the ordinary 4-cycle engine. At the Düsseldorf Exhibition this system was represented by two firms, the Gasmotorenfabrik Deutz and Louis Soest & Co. The Deutz works thus far have made the cylinder with a maximum of 250 to 300-horse power capacity the basis for their larger engines. In double and quadruple engines they, therefore, reach 1,000 to 1,200 horse power. At the exhibition they had a 1,000 to 1,200-horse power engine coupled direct to a Stumpf-Riedler blowing engine built by the Gutehoffnungs Huette. In a general way the engine possesses the advantages and disadvantages of the single acting 4-cycle motor. As compared with engines with a smaller number of cylinders, it has the advantage of greater regularity and of larger reserve in the case of the failure to work of one cylinder. Two cylinders each are placed on either side of the crankshaft. The most difficult detail, the cylinder head, has one admission and one exhaust valve, placed in special cages in such a manner that the admission valve is placed in the upper part and the exhaust valve in the lower part of the inner wall, and that a gas valve is placed in a casing screwed on. Since the engine does not have piston rods which pass through the cylinders, the exhaust valve, which is cooled by its hollow spindle, is accessible after removing the upper valve box. This is certainly an improvement in construction as compared with the former design with a large number of valves. The valves are operated by cams from the valve gear shaft. The latter and the driving gear are naturally, under normal conditions of working, put under a strain of 3 to 4 atmospheres when the exhaust valve is lifted.

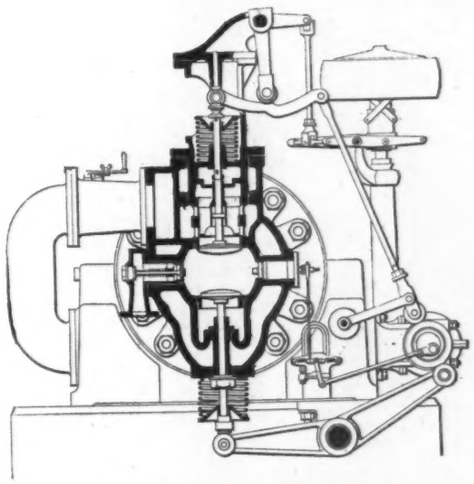

Fig. 3.—Section through Cylinder Head.

Single Acting Deutz 4-Cycle Engine.

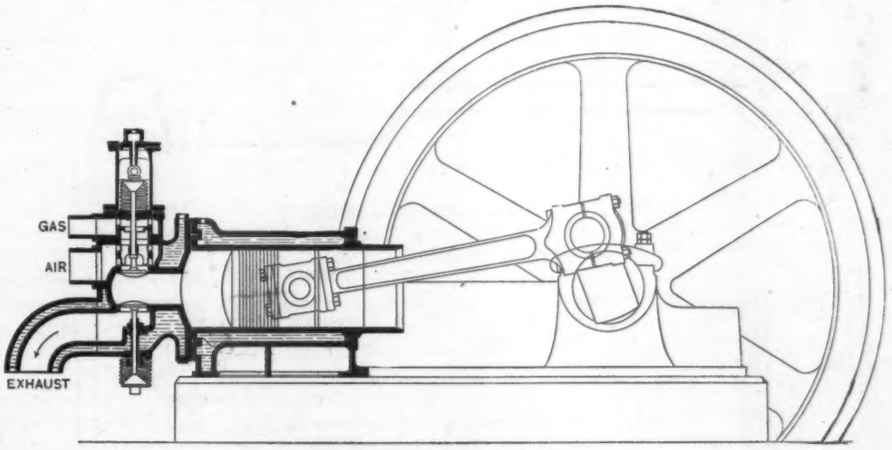

Fig. 4.—Longitudinal Section.

Single Acting Deutz 4-Cycle Engine.

Two Hartung governors whose rods are not coupled take care of the regulation. The well known phenomena of irregular working of the cylinders will appear, a fact which will not disturb the driving of blowing engines. The admission of gas is so regulated that with a light load the gas is supplied later, while a larger amount of air is drawn into the cylinder. When running with a light load or with no load, therefore, work must be done with dilute mixtures and the attendant drawbacks in regard to ignition.

The Deutz Company, like other works, have recently changed the governing gear. Fig. 3 shows the latest Deutz cylinder head in section. It will be observed that the gas valve and the inlet valve are combined with a piston valve for the admission of air in the same casing and are mounted on the same spindle. When the valve spindle is pressed down by the gear mechanism the inlet is first opened, and the air valve and the gas valve follow a moment later, opening inward or downward. All the parts thus moved must, therefore, be closed upward by the pressure of a powerful spring.

One end of the valve lever is attached to the valve spindle, the other end seizes a rod driven from the gear shaft. The support of the valve lever is a roller. When the driving rod is lifted the valve lever presses against the roller and the inlet valve is forced downward. When the driving rod descends the valve is gradually closed. The arrangement is so made that the valve opens with the beginning of the suction stroke and closes toward the end of that stroke. The roller is borne by a lever which oscillates on a shaft acted upon by the governor, and the valve lever is so shaped and so arranged that its upper surface, when the valve is closed, forms a circle tangential to the roller circumference, the center being the center of the shaft operated by the governor. When the governor by a turn of the shaft changes the position of the roller the valve is kept open for the same period of time as before, only it is opened more or less. The regulation, therefore, amounts to throttling of the supply of gas and air mixture in such a manner that by simultaneously changing the sections of the gas and air passages so that the mixture remains the same and only a larger or smaller quantity enters the cylinder. By this regulation, therefore, the compression is also changed. In spite of this the combustion and consequently the regularity of running and the gas consumption under light loads are said to be better than when the work is done with an excess of air and unchanged compression. In principle this gear is the same as that employed earlier by Koerting and by the Nuernberg shop. A thorough cooling of the flanges is provided in the new design of cylinder used, as is shown in Fig. 4.

I have not yet seen any engine provided with this gear in operation. The Deutz Company, however, advise me that they have a small 35-horse power motor of this type running, that the gear works very quietly and has only a slight back pressure.

Louis Soest & Co.—The firm of Louis Soest & Co. have exhibited a 300-horse power engine, the design of which is similar to that of well-known engines. It is well worked out and makes a pleasing impression. The piston is water cooled and the cylinder head has a gas valve and an inlet and exhaust valve, placed one above the other. The exhaust valve is located so low that dirt and oil residues may be blown out. The valves are located far into the cylinder head, so that the inner wall is partly cooled from within and from without. The firm note as a novelty the following arrangement: With a single turn of the hand it

1. *Iron Age.*

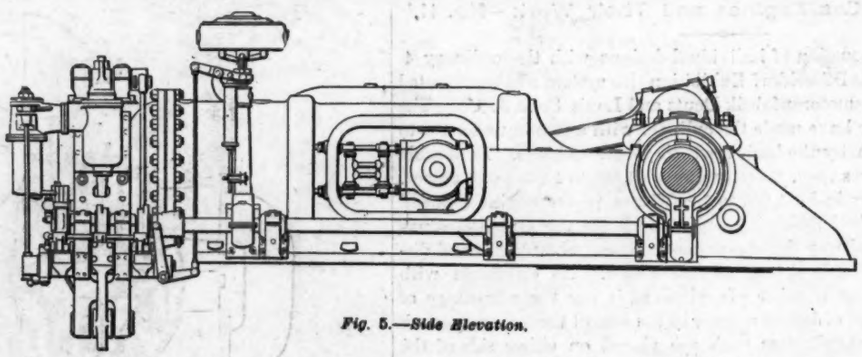

Fig. 5.—Side Elevation.

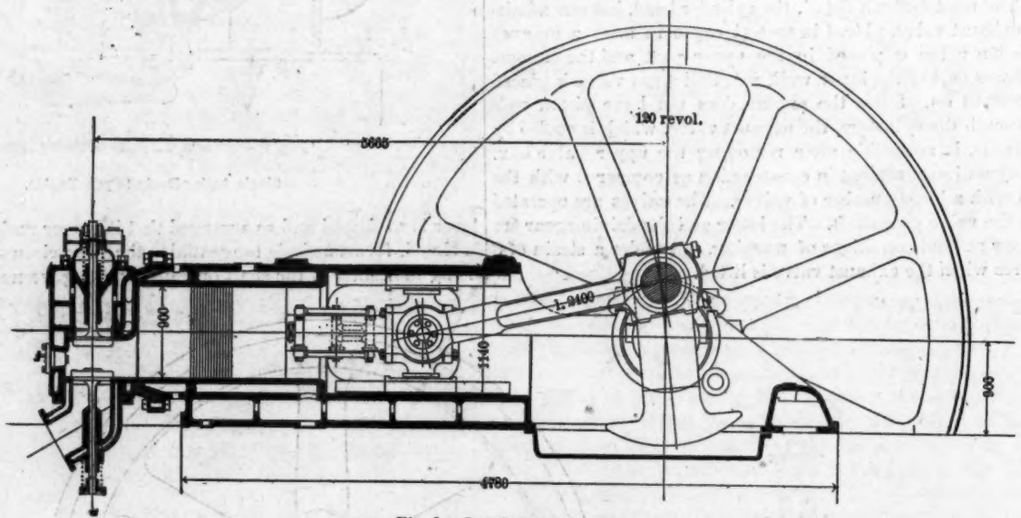

Fig. 6.—Longitudinal Section.

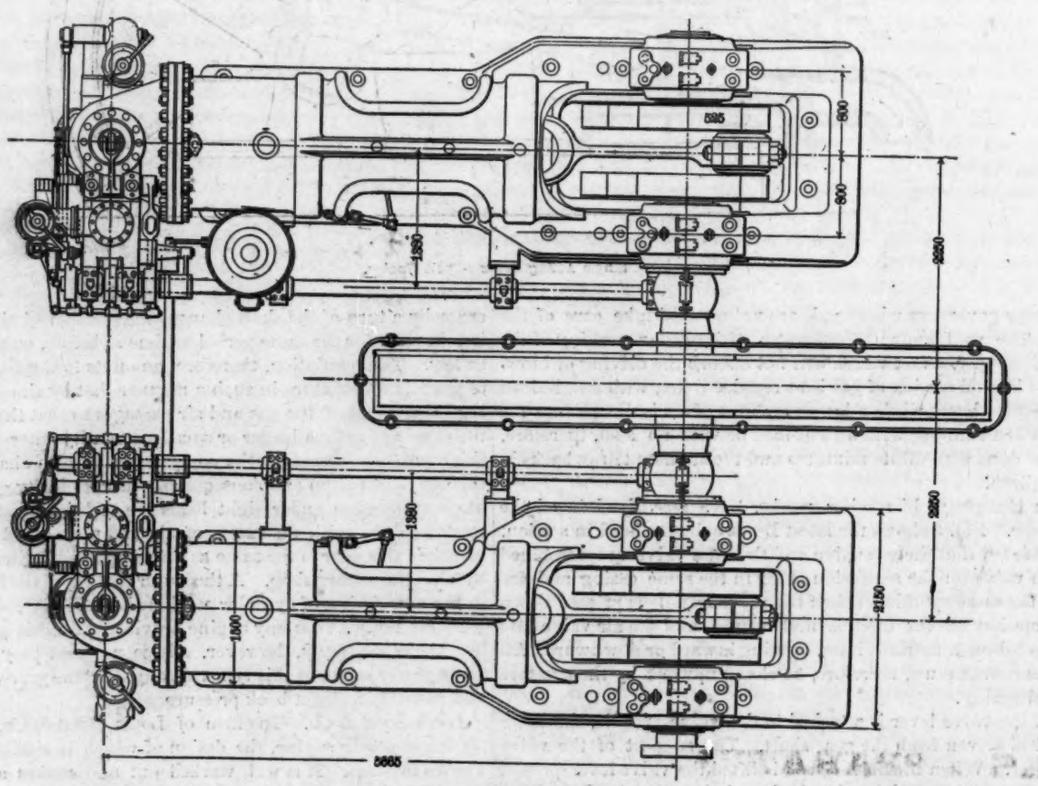

Fig. 7.—General Plan.

Soest 600-Horse Power Blast Furnace Gas Engine.

is possible, in starting, the movement of the inlet valve may be cut off, the exhaust valve is made to operate and is changed, with a lessening of the compression, to a 2-cycle movement. This arrangement is certainly practical. The first gas engine built by the firm is that shown at the Düsseldorf exhibition. Its work under normal condition cannot be judged because it was not doing work at the exposition. Soest & Co.

have also shown drawings of an engine of 600 to 700-horse power for which two orders are at hand. The engine has a cross head and is regulated by simultaneous changing of the gas and air mixture, Figs. 5, 6 and 7.

Smokeless Combustion of Bituminous Coal.

Engineering Magazine for December, in what it declares is "An International Symposium" on this subject, says that ever since the introduction of steam power attempts have been made to provide for the smokeless combustion of coal, and while the problem has been studied by able engineers from the time of Watt to the present, there is little doubt that the smoke question is daily becoming more pressing. In England, where all the coal used both for industrial and household purposes is entirely or partially bituminous, the subject has long been a matter for consideration, and the same has been true of Pittsburg and other cities in the United States in which soft coal is used. Until recently, however, a number of the large cities on the Atlantic coast of the United States have been free from the annoyances and discomforts of soft coal smoke, and it is only by reason of the prolonged labor troubles in the anthracite coal districts of Pennsylvania that the use of bituminous coal in New York, Philadelphia and other cities has called attention to the fact that the supply of anthracite must be considered as limited and irregular, and that the sooner the smokeless combustion of bituminous coal becomes the rule, the sooner the dominating power of a limited territory under the control of a few people, over the comfort and purse of the public will be terminated.

The supply of bituminous coal in the United States at least, and in Asia, is practically unlimited, and when it is properly burned it offers no difficulties or inconveniences, while at the same time its excellent calorific power renders it entirely satisfactory so far as steaming is concerned.

Among recent articles on the subject of the smokeless combustion of bituminous coal we note the excellent paper of Mr. W. H. Booth, presented at the Belfast meeting of the British Association, the exhaustive series of papers by Mr. Albert A. Cary, in late issues of the *Iron Age*, the communication of Mr. T. T. Parker, in the *American Machinist*, and various other articles, all bearing upon features of the problem.

These papers, while differing in their treatment of the subject, all agree in emphasizing the one fact that the usual appliances for burning bituminous coal in practice are constructed with entire disregard of the true principles of combustion.

Thus Mr. Booth says: "Engineers are taught at college that combustion can only take place in the presence of a sufficient supply of oxygen at a sufficiently high temperature. An ordinary class room experiment is to surround a candle flame with a coil of wire, which abstracts heat so rapidly from the flame as to cause combustion to cease, and the flame is extinguished. This experiment contains the whole secret of combustion. When engineers go out into the world, they find that the burning of coal and generation of steam are carried out upon lines which are quite opposed to the principles they were taught at college, and more upon the lines of the refrigerated candle flame experiment. They become aware that the daily practice of steam raising, while opposed to theory, is very far from good, and they are told that it is not possible to burn bituminous fuel except with evolution of smoke. Most engineers acquiesce in this very lamentable state of affairs, and are the more inclined to do so, because, where teachers of engineering have been responsible for boiler arrangements, they are unable to find that these present any differences from the common herd. The modern steam boiler is, in fact, quite as primitive as a common pan set directly upon a fire to boil. An African savage, with a gourd as his pot, places this to boil just as scientifically as do our professors of engineering place boilers. The modern boiler maker merely sells boilers. The consulting engineer, who ought to order their setting, accepts the methods of the savage, the impossibility of which, in respect of good results, he has taught, or has been taught at college, but has not comprehended."

Mr. Cary fully agrees with this position, saying:

"The smoke nuisance from boilers can be almost entirely avoided by the adoption of proper furnaces adapted to the fuel used and by the employment of a sufficient amount of intelligence to handle the fires properly. The whole secret of burning fuel smokelessly is to obtain complete combustion in the furnace and combustion chambers before any appreciable amount of the combustible gases meets the chilling water surfaces of the boiler."

While indeed there are certain fuels which show smokeless combustion, such as charcoal, coke and anthracite, these too demand proper conditions in order that the full thermal efficiency may be obtained from them, so that the whole question of the proper combustion of fuel for steam making can be reduced to certain fundamental principles.

Although these principles have been known for a long time, and their demonstration is included in every elementary course in physics, we see them almost totally ignored in engineering practice. In locomotives we find the combustion carried on in a contracted box in which five of the six walls are formed with water spaces, usually miscalled heating surface, but more properly entitled cooling surface. In the type of marine boiler in general use the fires are maintained in small cylindrical furnaces, than which nothing more effective for chilling the fire could well be devised. Water tube boilers are nearly always set with the tubes directly over the fire, while the horizontal tubular boiler, so extensively used in the United States, is also set directly above the grate.

The immense influence which these constructions have upon the combustion of the coal will be seen when it is understood that the igniting temperature of bituminous coal is between 700° and 800° F., while the temperature of the water in the boiler, and hence of the metallic surfaces close to the fire, is not more than one-half as much, and therefore complete combustion cannot be expected.

The idea of the practical man is that all this can be remedied by the admission of an excess of air, since he assumes that the presence of oxygen will suffice to make up for lack of temperature. In this he forgets that the finely divided particles of unburned carbon which constitute smoke cannot be so readily disposed of. The particles of carbon are really floating in an atmosphere of nitrogen and of carbonic acid, and in most cases the excess of air admitted never reaches the combustible at all, but serves only to dilute the whole, absorbing heat and passing out of the chimney unused.

The remedy for this state of affairs is obvious, so much so that many overlook it altogether If the furnace be removed altogether from its close proximity to the cooling surfaces of the boiler, and be surrounded by walls capable of being raised to a temperature higher than the critical igniting point of the fuel, there will be no difficulty in burning all the combustible constituents of the fuel, provided sufficient oxygen be provided. In other words there should be a separate furnace of ample size constructed, conveniently placed in front of the boiler, and containing only the grate, and including walls of firebrick capable of being maintained at a high temperature. The throat of the furnace can communicate directly with the flues or other heating surface of the boiler, and the intensely hot products of the already completed combustion thus delivered where they will do the most good without the possibility of producing smoke. Again the practical engineer interposes an objection. "We know," says he, "that the surfaces of the boiler exposed to the radiant heat from the fire constitute the most effective portion of the entire heating surface of the boiler; are these to be discarded?" As a matter of fact, we know nothing of the sort. We know that a large portion of the so-called heating surface is far inferior to the rest, but this is due to the fact that it is so placed that it receives only the partially consumed and already cooling portion of the fuel. The fuel contains a definite, and ascertainable number of heat units; when it is fully burned these heat units are released in the sensible form; and, if they do not escape through the walls of the furnace or up the chimney they must be absorbed by the boiler and utilized in the evaporation of water.

Furnaces of this kind are in continual and satisfactory use for the complete combustion of fuels which would be altogether worthless if fed upon the ordinary grate, such fuels as wet spent tan bark, bagasse from sugar mills, etc., and there is no earthly reason why methods entirely practical, and altogether theoretically correct, should not be used for bituminous coal, a fuel quite as unfit to be fed into a common furnace as any which could be named.

It has been said that much of the smoke in British cities comes from the chimneys of private residences, and that properly designed boiler furnaces would abate but a small portion of the evil. There is but one remedy to be offered for this portion of the problem, but it is one which should be promptly accepted. The only fuel fit for household purposes is gas. Fuel gas should be supplied to all houses in cities, and the use of solid fuel become as obsolete as that of flint and steel, tinder, and other ancient nuisances. There is no reason why any great city should be a victim of the smoke nuisance except that of the wilful perversity of its inhabitants, and those who are afflicted by the filth and unhealthfulness of an atmosphere laden with the products of incomplete combustion should receive no sympathy or commiseration from the more intelligent portions of the community.

Wire and Cable Specifications.

By Mr. L. T. Collins, *in Elec. World.*

That manufacturers of electrical wires and cables are often asked to bid on specifications unreasonable and sometimes absurd, is a fact so well known as scarcely to excite comment. As an instance of this, one of the largest manufacturers of electrical machinery in the world, recently sent out specifications on No. 12 B. & S. cables and smaller, with walls of rubber varying from 2 thirty-seconds to 3 sixty-fourths on which they required a test of 6,000 volts for thirty minutes and 9,000 for thirty seconds under water. These wires were for 500-volt service. As an example of extreme requirements in the opposite direction, one of the large electric lighting companies specified a 12 thirty-second wall of thirty per cent. Para compound on a No. 5 B. & S. stranded cable for a working pressure of about 6,000 volts and a test of 15,000 volts.

The many points to be considered in determining the proper wall of insulation for a given pressure, make hard and fast rules impossible. The manufacturers of electric wires and cables have had the widest experience along these lines, and with full knowledge of the conditions of service, their judgment is of the greatest value. Many users of electric wires and cables have learned this fact, and invariably consult one or more well-known manufacturers before drawing up specifications for cables to meet special conditions. The wisdom of this course is shown by the instances cited above. In one an excessive coefficient of safety makes the cable unnecessarily expensive, and gives the manufacturer who uses cheap compounds an unfair advantage. In the other, the coefficient of safety becomes a negative quantity, and the manufacturer must either refuse an order given under such specifications, or ignore them. In the latter case the risk is run of having the goods returned and general dissatisfaction and ill-feeling result.

While writing on this subject, it may be well to call the attention of purchasers of electric wires and cables to the fact, that however carefully they may draw specifications as to the percentage of Para required in the compound to be used, they are in a great measure dependent upon the honesty of the manufacturer. An inferior compound can be be made to give a high initial test. The general appearance and elasticity of the compound indicates only in a measure the quantity and quality of the rubber used, and the ash test, while determining the quantity of organic matter, does not show the quality of the rubber, merely the percentage. The consumer has to depend upon the honesty of the manufacturer, who often sees contracts awarded at little more than the cost of materials if the specifications were strictly complied with. For instance, the navy specifications call for a 40 per cent. Para compound, but the manufacturer whose figures are based on furnishing such a compound would be sadly left. In awarding contracts the reputation of the manufacturer for turning out good work—a reputation only acquired by years of honest effort—is seldom given proper consideration.

The acme of absurdity seems to have been reached in some of the rules of the National Board of Fire Underwriters. As these rules have a wide influence and are often embodied in specifications, a brief review of the ones specially referred to may help towards a sensible revision.

Beginning with Class D, Section 41, paragraph C, one finds this covers the insulation resistance for National Code wires and cables to be used at not over 600 volts. These are for interior work and are not supposed to be subjected to moisture, except such as may be in the air. Against sudden excessive moisture they are amply protected, as such a condition should be temporary. This rule calls for an insulation resistance of 100 megs. per mile, a reasonable and safe requirement. The test, however, is to be made, "*during thirty days' immersion in water at* 70° F." Clearly this means submersion for 30 days.

Ignoring the evident absurdity of submitting wires and cables for interior use to thirty days' submersion, while most marine cores receive a final test at the factory after forty-eight hours under water, let us consider some of the difficulties the manufacturers would have to overcome, if this rule was complied with.

There is probably not a factory in this country that has a fraction of the tanking capacity necessary to meet this requirement; to build the tanks would mean a useless outlay of thousands of dollars. Having built the tanks, however, the next step would involve locking up capital in stock, as a thirty days' supply would have to be carried. Assume these difficulties have been overcome and the problem solved of approximating (no exact figures could be made) the demand for the next thirty days, the manufacturer would be confronted with another difficulty. The demand for many sizes of National Code goods is so great, that it is almost impossible to accumulate a large stock of them. Again assume these difficulties have been overcome. Several large and unexpected orders arrive. The stock that has been in soak for thirty days is exhausted. Then a good customer sends in a rush order. Consider the painful position of the manufacturer. He must either refuse the order or offend his conscience by sending his customer stock unregenerated by having had only 28 or 29 days' baptism. Those who know the tenderness of manufacturers' consciences will realize the cruelty of this position. It is difficult to treat such a rule seriously, and one cannot escape the suspicion that it was never intended to be so treated.

If a more liberal interpretation is given to this rule, and one assumes that the intent is to submerge the wires and cables *from time to time* during a period of thirty days, it is no less absurd and almost as difficult to obey.

The above remarks are applicable to the rule regarding fixture wire (46 a), which having only one thirty-second wall of insulation, including braid, is allowed to escape after a seven days' soak.

Now as to pressure test (41 d) we find these wires and cables, which are to be used at not over 600 volts, are required to resist, "*Three thousand volts per one sixty-fourth of an inch thickness of insulation.*" This test must be made after 72 hours' immersion (41d, paragraph 2). Assuming that insulation means only the rubber, the pressure would be as follows:

No. 18 B. & S. to 16 B. & S. inclusive	1.32 wall	—	6,000	volts.
No. 14 B. & S. to 8 B. & S. "	3.64 "	—	9,000	"
No. 7 B. & S. to 2 B. & S. "	2.32 "	—	12,000	"
No. 1 B. & S. to 0000 B. & S. "	5.64 "	—	15,000	"
No. 4.0 B. & S. to 500,000 c. m. "	3.32 "	—	18,000	"
No. 500,000 c. m. to 100,000 c. m. "	7.64 "	—	21,000	"
Over 100,000 c. m.	4.32 "	—	24,000	"

The impossibility of meeting these tests must be evident to anyone familiar, in a practical way, with the manufacture and testing of electric wires and cables. One might as reasonably expect to force a quart of water into a pint measure without something giving way. The same test is applied to wires and cables for voltage between 600 and 3,500 (41 f) viz.: 3,000 volts for every one sixty-fourth wall of insulation.

The only apparent reason for issuing such rules is, that it was thought by requiring a great deal, more would be secured than if less were required. This reasoning is fallacious. Rules that are impossible to obey cannot be enforced, and the condition is the same as if no rules existed. The consequence is that manufacturers of high-grade wires and cables are forced into unjust competition with cheaply made goods, and the blame for losses due to defective insulation falls upon all. Rules like these and specifications that are equally unreasonable defeat the very object for which they are issued. Why should not so influential a body as the Board of Fire Underwriters set a good example by revising these rules in such a manner that while ample protection is assured, nothing unreasonable is required? Such rules could be enforced, if not fully, at least to such an extent as to make it unprofitable to risk using low-grade compounds. This would mean raising the standard of insulation and reduction of losses to all users of wires and cables. If such a condition were brought about, the fire insurance companies would be the greatest gainers.

Superheated Steam.

Mr. E. H. Foster, in a paper read at the last meeting of the Engine Builders' Association of the United States, said: There have probably been as many as 7,000, and possibly more, superheaters successfully installed by European manufacturers during the past 10 or 15 years, and the fact that the number of installations is rapidly increasing is the best proof that they are on the right track.

The general method of superheating steam is to take the saturated steam from a boiler drum and pass it through coils surrounded by heated gases. The coils may be placed within the boiler setting so as to intercept the gases from the boiler furnace in their passage through the boiler, or they may be placed in a setting independent of the boiler and supplied with heat by a furnace of their own, or they may be set outside of the boiler and supplied with heat by drawing a portion of the hot gases from the boiler furnace, passing it through the superheater and returning it to the boiler or economizer. The choice of a system must depend largely upon local conditions, such as space available, the style and size of boiler in use, arrangement of the steam piping, type of engines adopted, and their location with reference to the boilers.

The coils are made of seamless drawn steel tubing, or of cast iron of a suitable composition to stand high temperatures, important advantages being claimed for each. Whatever the method of construction adopted, the material used must be of the very best and the joints and connections made in the most approved manner and with the greatest care,

With such precautions as are now considered good practice the superheater may be depended upon as safely as the boiler, or engine, or any other part of the plant.

In considering the advantages and disadvantages of superheating with regard to engine work, let us recognize the four distinct conditions under which steam is used as follows:

(1) Saturated.
(2) Superdried.
(3) Moderately superheated.
(4) Highly superheated.

Saturated steam may be taken as commercially dry steam, or such as is delivered by a good boiler under ordinary conditions.

By superdried steam we mean steam which is not only thoroughly dried in the superheater, but which is raised in temperature some 30° or 40° above the saturation point, or just enough to insure its arriving at the engine in a perfectly dry state. To such an arrangement there could possibly be no objection, as the steam is delivered at the engine free from moisture and without the use of a separator or means of trapping out condensation.

By a moderate superheat we mean from 100° to 150° at the boiler, which should give in the neighborhood of 100° at the engine and be sufficient, with proper protection, to carry the steam nearly, if not quite, through one cylinder without condensation. If the engine is compound the steam, having lost its superheat at the terminal point of the high pressure cylinder, is resuperheated about 100° in a reheater between the high and low-pressure cylinders and again loses its superheat while expanding into the low pressure cylinder, arriving at the point of exhaust with the temperature of saturation. This arrangement may be considered at the present time as the best which can be proposed. The amount of superheat is so moderate as not to require anything more than good construction for modern high steam pressure.

Highly superheated steam must be treated with more consideration. Engines which will stand a temperature of 500° F. are not necessarily fitted to handle steam at 750°, but these temperatures may be, and have been repeatedly used successfully.

As shown by many published reports of tests at various points of superheat, an increase in temperature is accompanied by a decrease in steam consumption, hence it is worth while pursuing this line. To employ these high temperatures it is at present considered important to use poppet valves on the high-pressure cylinders at least, as it is here that the full effect of the superheat is felt, and this type of valve is easier to lubricate and does not become distorted with heat. We believe, however, that a Corliss valve may be so proportioned as to operate successfully even under these conditions.

One of the well-known methods of utilizing high superheat is that known as the Schmidt system. This consists in passing a portion of the highly superheated steam directly from the boiler through the reheating tubes of a receiver, between the high and low-pressure cylinders of a compound engine, and then letting this steam mix with that which enters the high-pressure cylinders direct from the boiler. The high-pressure exhaust is thus superheated on its way to the low-pressure cylinder while the temperature of the steam admitted to the high-pressure cylinder is modified by its admixture with steam which has already been through the reheater coils and incidentally a receiver drain is unnecessary. Automatic regulation of the superheat to a desirable point in each cylinder, under a varying load, is claimed for this system. Ordinarily an increase of load beyond normal, necessitating a large point of cut off in the high pressure cylinder, will give an excess of superheat in this cylinder, while the reheater will not be sufficiently active to superheat this steam on its way to the second cylinder. With the Schmidt system, however, this effect is reversed by causing a greater amount of steam to pass through the receiver coils, where it gives up its superheat to the low-pressure cylinder during periods of heavy draft, and the high-pressure cylinder is thus protected from excessive heat. The contrary effect in both instances may be followed through in case of an engine running under a light load.

In the present state of the art it would seem that the condition most attractive to American engine builders would be one of moderate superheat. We thus confine ourselves to a conservative policy and avoid the necessity for making any special provision for extremely high temperature. We use lubricates and gaskets and packing, which may be obtained in the open market at a reasonable cost, while at the same time we avail ourselves of such positive and direct benefits of superheating as:

Dry steam in the pipes and throughout the engine.
Elimination of separator.
Low steam consumption per unit of work done.
Smaller steam pipes and ports.
Simplified system of steam jackets.
Greater amount of work done per boiler capacity.
Efficiency at light loads.

These are all practical and common sense improvements, and are of such proportion as to fix our attention.

The absence of water with the steam need not be dwelt upon. Every practical man will admit that this is of great value. It is further noticeable that a steam pipe system which will show leakage at the joints with saturated steam will become perfectly tight under superheated steam.

The point of maximum economy, while using superheated steam, has by no means been reached. The amount of data available is not in proportion to the extent of the practice. In order to make a comparison between superheated and saturated steam consumption of an engine, it is, of course, only fair to place both on a heat unit basis, thus eliminating entirely the question of the cost of the superheat. Assuming a compound engine of about 1,000-horse power and running with 150 lbs. initial and 26-in. vacuum, we would consider 12½ lbs of fuel per indicated horse power per hour a very good result. We have well authenticated reports of a similar engine, supplied with steam with a temperature of 720° F. at the boiler, consuming less than 9 lbs. of steam per indicated horse power, or a gain of 39 per cent. in economy with an expenditure of but 16 per cent. more heat units in the boiler.

The reduction in the size of steam pipes and ports rendered possible by using superheated steam is due to the diminished density of an equal volume as compared with saturated steam as well as from the absence of entrained water. The velocity of superheated steam in pipes should be kept up in the neighborhood of 6,000 feet per minute. As a rough approximation it may be said that superheating will make a difference of 20 per cent. in the size of the steam pipe.

The question of steam jackets on a cylinder, which has occupied so much profound attention in recent years, is quickly solved by the aid of superheated steam, and we see at once the benefit of the jacket disappear as a steam economizer. There seems to be no excuse for retaining them on the low-pressure cylinder, and indeed we have proved by trial that on this cylinder a steam jacket is positively wasteful. We do not think it is clearly proved, however, that they may not still be useful when applied to the high pressure cylinder, even if only for the sake of warming a large engine up preliminary to starting.

The effect of getting more work out of a certain volume of steam is naturally felt in the handling of the boilers and in a reduction in the number of fires necessary to do a given amount of work.

Unexpected results have been frequently obtained by the addition of a superheater to a boiler and a higher evaporative efficiency with the superheater in commission has been shown. This is doubtless due to the increase of the heating surface and the lowering of the temperature of the flue gases. In such cases the saving by superheating is felt in the coal pile to the same extent as in the steam consumption.

On the acceptance test of some vertical compound engines of 1,200 and 2,400 horse power on electric light service in Boston the maintaining of efficiency under light loads was well demonstrated. The feed water per indicated horse power per hour was 12.54, 12.51 and 12.06 lbs. at full load, three-quarter load and one-half load respectively, while the amount of superheat was 80°, 64° and 48° at the high pressure admission and 60°, 67° and 84° at the low pressure admission. The engine had reheaters and steam jackets on both cylinders, and it is not unlikely that still better results would have been obtained had the low pressure jackets been omitted.

It must not be considered necessary to make any very extensive preparations for the use of superheated steam; it may almost be said that the requirements are merely in the line of good practice, and, as such, should be inaugurated in any event. It is important to have the joints of the steam pipes firmly made and well bolted; corrugated brass gaskets are usually found very satisfactory with superheated steam. Provision must, of course, be made for the expansion and contraction of the steam lines to a somewhat greater extent than ordinarily, and the steam pipes, as well as the flanged unions, should be covered with a good non-conducting material in a thick layer. It is important to have the flanged unions covered as well as the pipe.

With proper precautions of this sort, and with a velocity of steam in the pipes of from 4,000 to 6,000 feet per minute, the drop in temperature per foot of run may easily be kept down to 1° in 6 or 7 feet of length.

Metal of low melting point must, of course, be avoided in the construction of the engine, especially about the valves and piston roads. The stuffing box bushings must be made of metal which will not run under the temperatures likely to be encountered. The metal should be uniformly distributed in designing the valves and cylinders to get the

best results with superheated steam, as in this way a uniform expansion by heat is provided for. The barrels of the cylinders are preferably made without projections or ribs. The poppet valve has the advantage in form, but the Corliss valve is also made in such a manner as to expand and contract without warping, and the large number of Corliss engines using superheated steam is a strong evidence of their adaptability.

The lubrication of the cylinders is apt to cause one who has not had experience with superheated steam a great deal of unnecessary anxiety, but really this problem is very simple. It must be borne in mind that the temperature inside of the cylinder is never very high, even when the superheat at the entrance is very considerable, and if the cylinder is lubricated directly without mixing the oil with the steam at the entrance point there can be no possible difficulty. With any reasonably good grade mineral oil, however, it cannot be claimed that any difficulty has been experienced with the lubrication of the parts, even when applied in the ordinary way.

The effect of superheated steam in the indicator diagrams is worthy of notice. Steam being used as a perfect gas, the diagram approaches more nearly the theoretical, and, as there can be no re-evaporation in the cylinder the tendency of the pressure to rise during the stroke is absent and the amount of work done in the low pressure cylinder is brought down to the proper point. In designing an engine to be run with superheated steam it is well to bear this point in mind, as there is danger of applying the usual constants in the selection of the size of the cylinder, for the reason that the horse power of the steam end used with superheated steam will be nearer the theoretical.

Although there has been less experience in using superheated steam on locomotives, it cannot be said that this field is of minor importance. Trials have been made on the Canadian Pacific Ry. and are now being conducted on the Pennsylvania R.R., which will doubtless contribute much to the knowledge of this subject. In the former instance it was found that by the addition of a superheater a simple engine weighing 204,000 was enabled to do 60 per cent. better in equivalent ton miles hauled per ton of coal than a similar engine without superheated steam. We should expect better results from a compound engine with superheated steam, and doubtless later experiments will bring out this feature. It is of inestimable importance to railroads if, as is apparently true, that with the same boiler power they are able to use larger cylinders and haul more cars.

Superheated steam is destined to play an important part in the adoption of the steam turbine. Already a number of tests have been published which show a considerable decrease in the steam consumption with the amount of superheating, and it is not difficult to understand that a machine of this type would be greatly benefited, even by the elimination of moisture and dense vapor from the propelling medium.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

"Brick-in-Hat" Man.

* * * * * VA., Dec. 15, 1902.

To the Editors AMERICAN GAS LIGHT JOURNAL:

The above man is of great utility to a gas company; I have dubbed him "Brick-in-Hat" for reasons that are fairly obvious. He would be very essential to the vital interest of a company in more ways than one. Some gas corporations may have such a man; but I do not know of them.

First, he should be a practical workman in his line, and an unerring reader of the gas meter; these are primary requisites. His duties are such, if properly discharged, as would make him indispensable to any good gas company. Every gas company knows the necessity of having all meters read promptly and accurately each month. His duty should be to *read* and *thoroughly inspect* each meter, to note any defects in same, turn in his readings and start right out to remedy such defects as he may find. While he is engaged in this work the poor, old bookkeeper is preparing himself to be kicked off the gravel dump. When the bills are presented for payment by the collector then the circus opens, and when Mr. "Know-it-All" or Mrs. "Can't tell me anything about it" comes into the office, like a half-sled on a hillside, and thrusts an "enormous, out of all reason" bill in the bookkeeper's face, and says, with fire in eyes, "You knew I could not have burned it," then Mr. Bookkeeper could say with all suavity, "Why, certainly; I will have the meter re-read." And out they go, with the refrain: "Well, I should *think you would.*" Then call in your "Brick-in-the-Hat" man and start him on his second duty, to go and thoroughly examine the meter. If he finds it correct, have him go from the meter direct to the grand, old grumbler, and say this bill is positively correct, according to the second reading of the meter, and collect the account then and there, while matters are plain and fresh; or, while the fight is on, carry it to a finish, which would diminish the ardor for future kicking when they encountered a "Brick in the Hat." There would be fewer disputed bills, fewer delinquents, when the kickers once find out that he carries a wrench in his pocket—to cut off gas, and a "brick in his hat" that can be kicked at with damage only to the kicker. He could then proceed to reform cranky meters and stop leaks, all of which would nourish and invigorate the strength of the company. By the time he accomplishes this work in a thorough and systematic way, it will be nearing the time to read again!

Levity aside, I do think such a man is the most effective weapon a company could use, as his work would cut out many gas ills and bring about a clearer state of things pertaining to meter reading, than having first "Dick," then "Tom," and afterwards "Harry," reading first one month and next the other. The general pipe and fitter man has his own troubles, and so has the superintendent. Their time is limited. If called on to read meters they hasten to read and return in order to get at their regular duties, hence errors creep in, and then the burden of explaining and satisfying a dissatisfied customer is thrown on the office man, who cannot get out to see if the complaint is just or unjust. Any fair sized company could afford such a man and his salary could be paid out of leak percentage. He could also look up the delinquents who have no complaints to make, but absent themselves from office pay day. Once they knew he was on their trail, and his war cry was, "No light to-night, or pay up," they would soon learn to pay. It is no kindness, really, to extend time, even to consumers of moderate means, because they will allow leniency to carry them beyond their ability to pay, even if they desire ever so much so to do; whereas, had they been *pressed* into paying one bill, they could have done so, where now it is impossible for them to pay several.

He can also put in new meters where the fitter has *piped* for them, remove old ones, keep an eye on the birds that emigrate from one locality to another, leaving a month's or a portion of a month's bill unpaid, run them down and locate new customers at the same time. In fact, he would be an all-around, good accession to any gas company, and if he properly performs his duties, the *kickers* would hardly be worth fretting about.

Who has a real, first-class "brick-in-the-hat" man? I venture the assertion if one is found, the company that has him has fewer complaints, fewer leaky meters, smaller percentage of leakages, fewer delinquents, and last, but not least, larger dividends.

Yours truly, G. M. F.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. P. E. HALL, JR., has succeeded Mr. H. W. Burkhart as Superintendent of the Everett (Wash.) Northwest Light and Power Company. A new bench of 6's has been ordered from the Parker-Russell Mining and Manufacturing Company, of St. Louis, to reinforce the present generating capacity of the gas plant, which is now close to its maximum. Gas for both fuel and light is being availed of freely by the residents, and the rapid growth of Everett is also largely responsible for the need of extensions to the plant, which has been in operation for only something over a year.

THE following circular has just been issued by the proprietors of the City Gas Light Company, of Ocean City, N. J.: "The City Gas Light Company begs to announce that its gas plant at Ocean City will be in operation by June 1, 1903, and hopes that you will make arrangements to use gas for both lighting and fuel purposes. It will supply a first class quality of gas at $1.50 net per 1,000 cubic feet. If your property is not already piped for gas, the local gasfitters are now taking orders for such work at favorable rates. The service pipe from the main to curb will be run free of charge, and the balance, from curb to house, at a nominal price per foot, not exceeding 15 cents. There will be no charge for the use of the meter nor for setting the same. The Company proposes to furnish and connect the standard makes of gas ranges at cost prices. Upon receipt of the inclosed blank [the blank is prepared on a postal card properly addressed to the Company] dated and signed, the Company will be glad to enter your order for a service and meter." Appended to the circular is a list of the names and addresses of the gasfitters in Ocean City.

"THE experienced services of Mr. George F. Macmun, of Southboro, Mass., have been temporarily secured as Superintendent of the Rich-

mond (Ky.) Water and Light Company, in order to put the plant in perfect condition.—S."

WE understand that the proposed transfer of the stock (amounting to control) in the Knoxville (Tenn.) Gas Light Company to the purchasing syndicate has not been completed.

THE Massachusetts Board of Gas and Electric Light Commissioners have been petitioned by the proprietors of the Newburyport Gas and Electric Light Company for permission to issue $150,000 of additional capital stock.

MR. F. B. ALDRICH has resigned the position of General Manager to the Wyandotte Gas Company, of Bethlehem, Pa., in order to assume charge of the following syndicated companies: Pottsville (Pa.) Gas Company, Schuylkill Haven (Pa.) Gas and Water Company, Schuylkill County (Pa.) Gas Company, Bath (N. Y.) Electric and Gas Company, Easton (Md.) Gas Light and Fuel Company and the Easton (Md.) Electric Light Company.

WE are indebted to a correspondent at Lansing, Mich., for the following: "The Lansing Gas Light Company will reduce the price of gas to its consumers after January 12, 1903, so that for bills paid on or before the 10th of the following month, the rate will be at the exceedingly reasonable net prices of $1.17 per 1,000 cubic feet for light and 94½ cents for fuel. The present prices are $1.50 for light and $1.10 for fuel. This reduction is made in accordance with the provision in the Comdany's charter, which was extended in 1898. A comparison of the prices of gas in this city with those of other cities of its size and situation shows that Lansing citizens secure their gas at a very low price, as low as in any city of its size. In addition to this, the Lansing Gas Light Company pays an annual specific tax of 3 per cent. on its gross receipts from gas, which amounts to a very considerable sum to turn into the city's strong box. This is in addition to its regular real and personal taxes. Very few companies in the entire country contribute as much in proportion to the city's support. The Company's Secretary L. E. Walker, says that up to the first of the month the Gas Company had expended so far this year $24,417.87 for extensions and improvements, besides which there is now under construction a line of large main pipe on Capitol avenue south, which will bring the construction account for the year up to about $30,000, a large part of which is expended for local labor. This does not include the regular wages, repair nor contingent accounts, which in themselves foot up a very considerable sum. Everything pertaining to the manufacture and sale of gas is at the highest point in many years, if not in the history of its production, and were it not for corresponding improvements, gas appliances which admit of the more general use of gas for fuel and light, few gas companies would be in existence to-day. The Company expects, as soon as the weather will permit, to begin work on its new plant on the site near the foot of Pine street, extending from Willow street to the river, and expects to have, when completed, one of the most up-to-date plants in the State."

THE gas plant of the River Falls (Wis.) Heat and Power Company has been shut down. It was of the oil gas type. More than likely the Company will put in a modern plant next spring.

IT is reported that the Philadelphia Company has acquired five-sevenths of the stock of the South Side Gas Company, of Pittsburg, Pa.

EDWARD R. ELLICOTT, City Electrician of Chicago, announces that the city is ready to accept proposals for "approximately" 2,000 old gas lamp posts.

THE New Haven (Conn.) Gas Light Company has declared a quarterly dividend of 2½ per cent., payable the 1st prox.

MR. WARREN J. FLICK, of Wilkes-Barre, Pa., has been appointed to succeed Mr. F. B. Aldrich as General Manager of the Wyandotte Gas Company, of Bethlehem, Pa.

AT the annual meeting of the shareholders in the Waynesboro (Pa.) Gas Company the Directors chosen were: W. H. Brown, Val. Smith, Wm. Middlekauff, John M. Wolf, M. T. Brown (who succeeds John W. Clugston), E. O. Blair and C. W. Schaibley.

ADVICES from Boston are to the effect that the Malden (Mass.) Gas Company has refused to sell more than one bushel of coke at a time to any one person. The moving cause was the greed of some of the storekeepers, who were retailing coke at an average rate of $18 per ton. The Company some time ago agreed to supply certain dealers at the rate of 7 cents per bnshel, the dealers not to ask in excess of 10 cents per bushel. The dealers broke their compact, and now those who want coke must apply direct to the Company, and they will not be allowed to purchase more than a single bushel.

IT is said that Messrs. S. B. Elkins and G. C. Sturgess have secured a controlling interest in the properties of the Union Gas and Oil Company, of Morgantown, W. Va.

THE plant of the Sunbury (Pa.) Company is to be enlarged.

IT is understood that arrangements looking to the amalgamating of the properties of the Honesdale (Pa.) Gas Company and of the Honesdale Electric Light Company have so far progressed that the union will be an accomplished fact by the 1st prox.

AT a special meeting of the shareholders in the California Gas and Electric Company, held in San Francisco some days ago, it was voted to issue $10,000,000 of 20-year 5 per cent. bonds. Later on it was voted to reduce the capital stock to $15,000,000, from $30,000,000.

"COUNCILMAN 'MIKE' DOWD, whom everybody in Lexington, Ky., knows as the 'extracting' collector for the local gas company, has been appointed night watchman at the Court House." So writes a Lexington correspondent.

THE new plant of the Painesville (O.) Gas Light and Coke Company is in satisfactory operation.

ACCORDING to the report of Mr. S. L. Monroe, City Clerk of Alexandria, Va., the gain in sendout for the 6 months ended November 30th last, as compared with the corresponding period for 1901, amounted to 17 per cent. The Alexandria plant is operated on municipal account, and it is much in need of repair.

"F. M. W.," WRITING from Houston, Tex., under date of the 15th inst., says it is practically assured that at the next meeting of the Directors of the Houston Gas Light Company a reduction in the selling rate will be ordered. It is surmised the price will be cut from $1.80 per 1,000 cubic feet to $1.50.

THE shareholders of the Watsonville (Cal.) Gas Company will, at 1 P.M. of February 10th, be called to vote upon increasing the Company's stock from $50,000 to $80,000, and to create a bonded indebtedness of $50,000. The bonds are to run for 20 years, and are to bear 6 per cent. interest.

THE proprietors of the Freeport (Ills.) Gas Light and Coke Company have added largely to their real estate through the purchase of what is known as the Green tract.

"A. B. S." FORWARDS the following from Providence, R. I.: "An important decision was recently arrived at in a meeting of the Executive Committee of the Narragansett Electric Lighting Company, it being a proposition that the Company consolidate with the Providence Gas Company. It was decided to present the proposition to the Gas Company at once and if an arrangement could be made satisfactory to the stockholders of both companies that the consolidation would go through. Some time ago talk was rife of a merger of the Union Railroad Company, the Narragansett Electric Lighting Company and the Providence Gas Company, but it fell through. The Philadelphia Company, which at present controls the street railways of Providence and vicinity, has had two or three conferences with the Electric Light Company on the question of leasing or purchasing the Narragansett property, but they were not able to agree and the matter has remained at a standstill. The Committee of the Electric Light Company, which has now voted to make a proposition to the Gas Company, is made up of prominent stockholders of the concern, among whom are Colonel S. P. Colt, Dr. Fenner H. Peckham, Arthur H. Watson, Howard O. Sturges, Judge Douglas and President Robinson of the Gorham Company. It is reported that some of the Committee thought that inasmuch as both the Gas and Electric Light Companies are in practically the same line of business, an alliance will be to the advantage of both. There is still, however, a possibility of the original merger going through. There was a difference of opinion at the former attempt as to what terms were proper in the acquirement of the properties, but another conference between the parties interested is liable to take place at any time when satisfactory arrangements may be made."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

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MONDAY, DECEMBER 22, 1902.

The Market for Gas Securities.

Confidence on the part of speculators for the long account seems to be returning. Likely, provision for disbursements on dividend account, for mid-December to mid-January, having been completed, rates for money on call or time may be obtained on a much more favorable basis now than for some weeks past. Consolidated shows a gain of 2 points in the bid price for the week; the closing to-day (Friday) having been made at 210¼ to 211¼. The shares should within a fortnight be above the "twenties." City gas bonds of all sorts are in good demand.

Brooklyn Union is 220 bid, but none of the stock seems to be on the market. Baltimore Consolidated is weaker, and Washington (D.C.) gas is also on the declining schedule. Peoples, of Chicago, is well held. Good advisers predict much higher prices for Indianapolis gas.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

DECEMBER 22.

☞All communications will receive particular attention.

☞The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	210¼	211⅛
Central Union, Bonds, 5's	3,000,000	1,000	110	112
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,500,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	350	..
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co.—				
Bonds, 5's	11,000,000	1,000	112½	113
Northern Union, Bonds, 5's	1,250,000	1,000	108	110
New York and East River—				
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	109	111
Standard	5,000,000	100	130	140
Preferred	5,000,000	100	150	160
Bonds, 1st Mortgage, 5's	1,500,000	1,000	115⅛	118
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	220	225
" " Bonds (5's)	15 000,000	1,000	119	119½
Bay State	50,000,000	50	1⅝	1¾
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	7½	10
" " Bonds, 5's	5,254,000	1,000	75	77
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		
Central San Francisco	900,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	99½	101
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101½
Columbus (O.) Gas Lt. & Heating Co.	1,682,780	100	88¾	89¼
Preferred	3,026,500	100	107½	109
Consumers, Jersey City Bonds	600,000	1,000	103	106
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	70	70¼
Mortgage, 6's	3,500,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	86	87
Consolidated G. & E. Co.'s. Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,825,500	50	.	89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	832,000	1,000	77	79
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	.	.
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	..	68½
" Bonds, 6's	2,650,000	..	102	105
Jackson Gas Co.	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	75	85
Preferred	2,500,000	100	100	105
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	112	120
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	25	87
Montreal, Canada	2,000,000	100	218	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	1,000,000	25	300	325
Nashville Gas Lt. Co.	1,000,000	100	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	101¼	101⅝
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	41½	42½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	113½	115
General Mortgage, 5's	2,465,000	1,000	92	93
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	95	96¼
Syracuse, N. Y.	1,975,000	100	29	..
Bonds	2,047,000	1,000	99½	100
Washington, D. C	2,600,000	20	375	380
First mortgage 6's	600,000	..	..	..
Western, Milwaukee. Bonds, 5's	4,000,000	..	109½	110
Wilmington, Del.	600,000	50	232	..

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILADELPHIA, PA., Dec. 10, 1902.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Jan. 15th, 1903, to stockholders of record at the close of business, Dec. 31, 1902. Checks will be mailed.

1436-5 LEWIS LILLIE, Treasurer.

Position Wanted

To Manage Coal or Water Gas Plant,

By a young, practical gas man of 15 years' experience. References.

Address, "J.,"

1437-1 Care this Journal.

Situation Wanted

By a Superintendent of Many Years' Experience

In the manufacture and distribution of coal gas, laying mains and services, handling gas stove trade, repairing and setting meters, and all work pertaining to the business. Best of references.

1434-2m Address, "E. M.," care this Journal.

WANTED,

Position as Manager or Superintendent of Gas or Electric Interests.

Ten years' experience in construction, operation and management. Last 4 years in South

1437-2 Address, "P. O. BOX 51," Jacksonvile, Fla.

SUPERINTENDENT

WANTS POSITION.

Young man of thorough experiense in every department of the business. Can guarantee results in manufacturing, and can instil the necessary energy into the hunt for new business. Good record and excellent references.

1435-3 Address, "DIVIDENDS," care this Journal.

Position Wanted

As Superintendent or Manager,

By a hustling young business man, who has had many years' experience in the successful management of coal, water and natural gas plants. Best of references.

1436-3 Address, "D.," care this Journal.

Wanted, Position

As General Bookkeeper with a Gas Company,

By a man of 17 years' experience. Is familiar with the McMillin system of gas accounting. Can furnish references. Please state salary paid. Address, "BOOKKEEPER,"

1433-6m Care this Journal.

WANTED,

A Gas Engineer or Competent Draftsman,

Experienced in drawing plans for bench construction, and remodelling and extension of a large gas plant. Apply to the

CINCINNATI GAS & ELECTRIC CO.,

1437-3 CINCINNATI, O.

WANTED,

Competent Man as Local Superintendent

For gas and electric light plant in city of 12,000. References required.

1437-1 Address, "W. G. L.," care this Journal.

WANTED,

Second-hand Station Meter,

from 60 to 72 inches diameter.

Four Purifying Boxes, 9 feet by 12 feet, or about that capacity.

1416-tf Address, G. M. ROSSMAN, Treas., Keene, N. H.

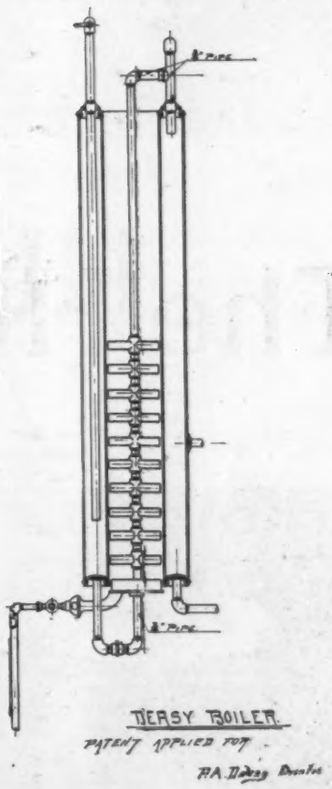
FOR SALE.

A GAS PLANT

In prosperous Western county seat.

1436-3 Address, "OWNER," care this Journal.

Conservation of Heat.



An Instantaneous Water Heater all Over the House.

25 gallons of water heated to 200° F. with a consumption of TWENTY feet of gas in TWENTY MINUTES.

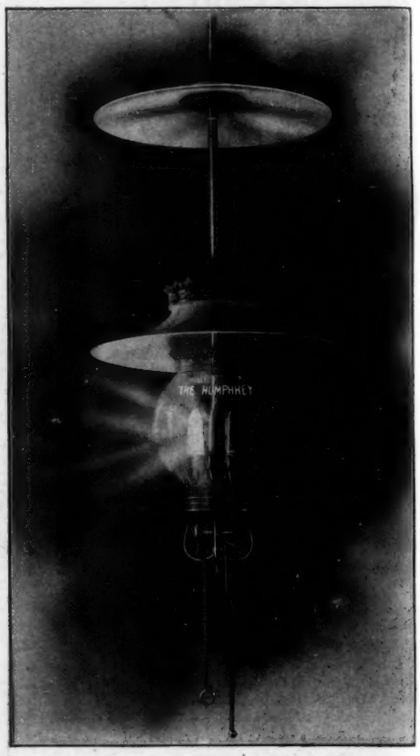
STATE RIGHTS FOR SALE.

Deasy Water Heater Co,

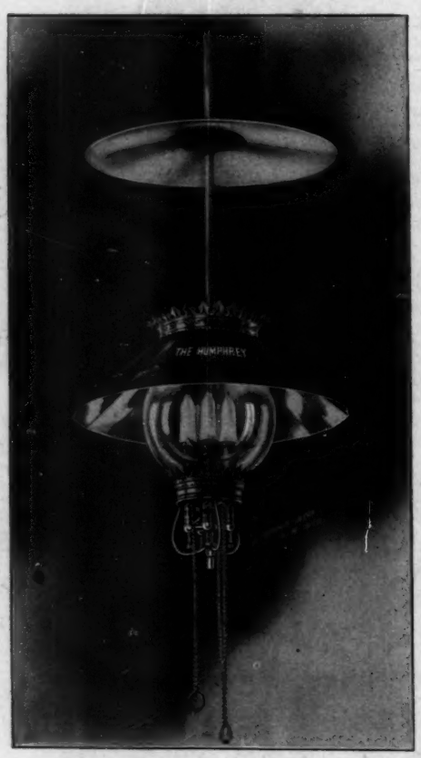
13th and Clay Sts., Oakland, Cal.

For General Store Lighting.

For Store Lighting with One MANTLE NIGHT LAMP.



The HUMPHREY, THE LIGHT THAT'S RIGHT.



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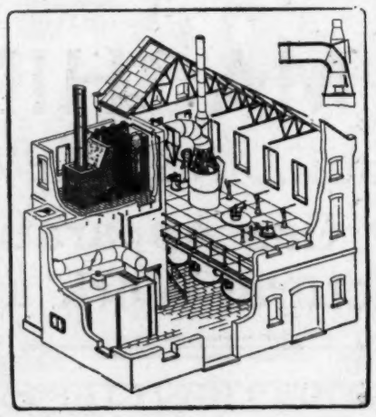

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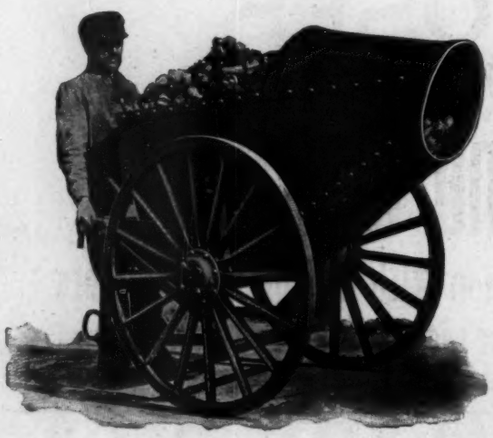

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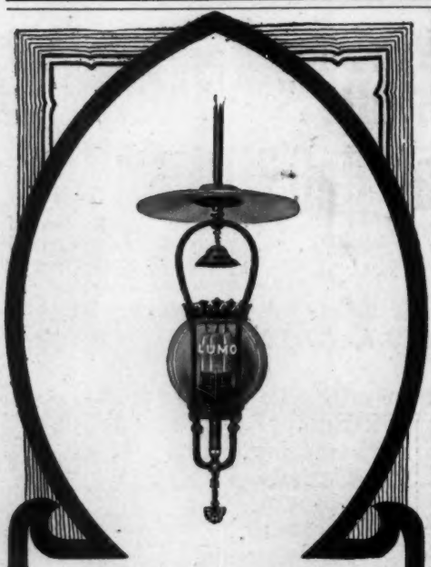

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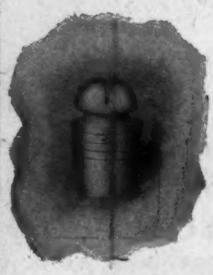

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No Chimneys to Break.
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Consumes Less Gas.
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Cox's High Pressure Fluid Discharge Computer.

This Computer solves the following formula, which is applicable to Gas, Air and other elastic fluids, flowing through long pipes with high initial pressures:

Discharge in cubic feet per hour at atmospheric pressure $= 33.3 \sqrt{\frac{d^5 \times (p_1^2 - p_2^2)}{L \times w}}$

Where

d = diameter of pipe in inches,

p_1 = absolute initial pressure in pounds per square inch,

p_2 = absolute terminal pressure in pounds per square inch,

L = length of pipe in miles,

w = specific gravity of the fluid when air = 1.

To Find the Discharge from a Pipe and the Required Size of Pipe.

(1.) Set the specific gravity of the fluid opposite the length of pipe;

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WE are building a line of Exhausters as per cut herewith, for forcing gas long distances and under pressures that are higher than ordinary pressures.

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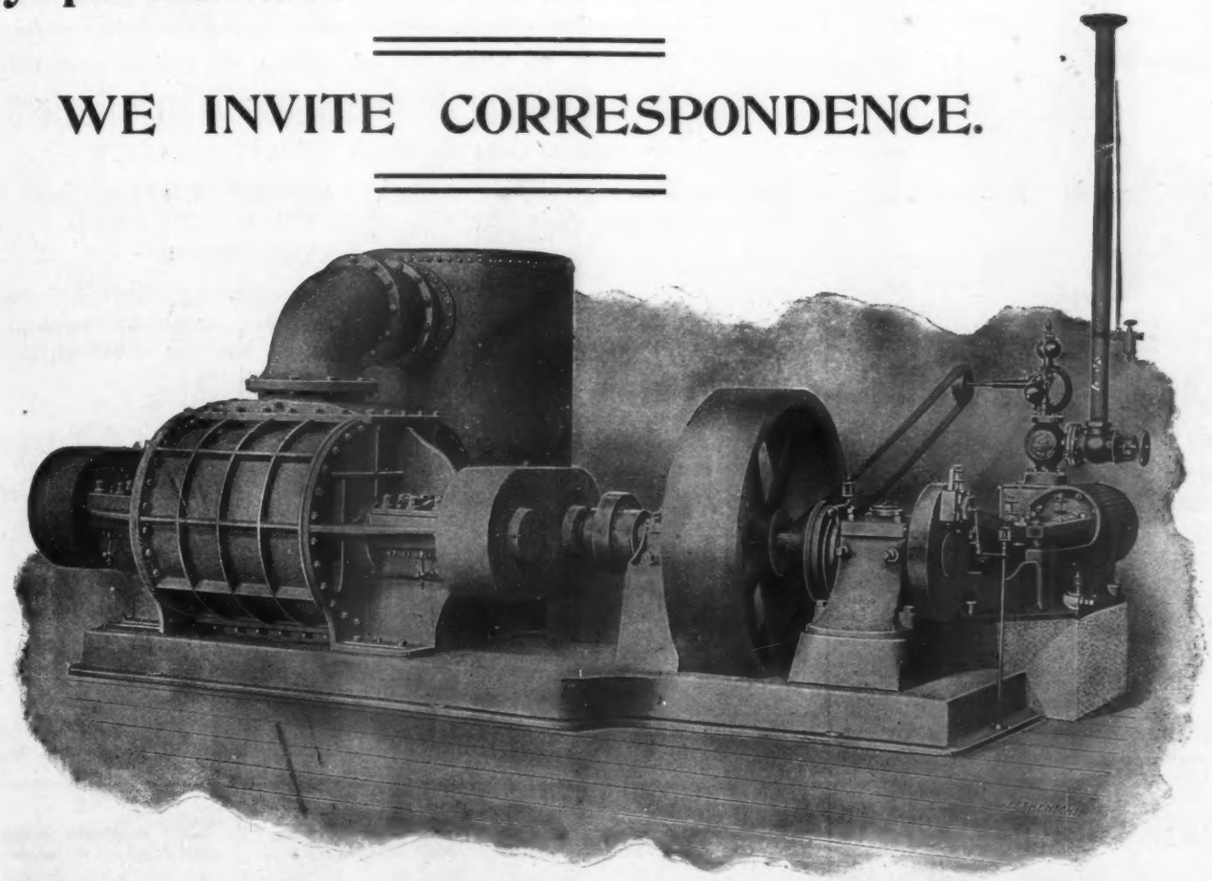

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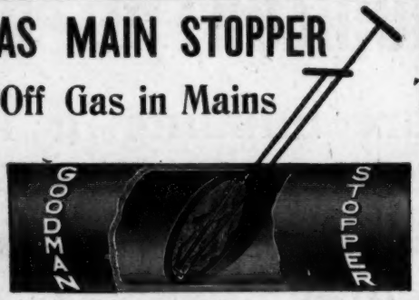

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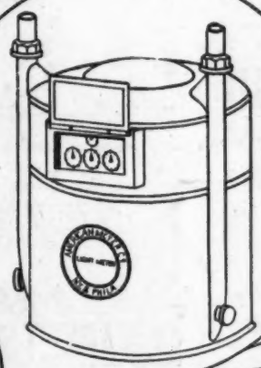

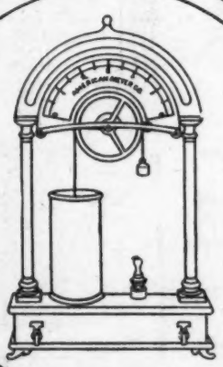

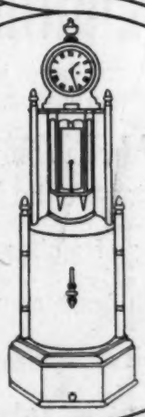

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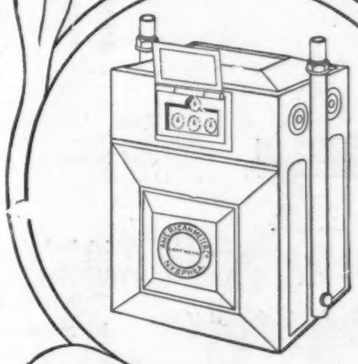
PUBLIC LIGHTING TABLE.

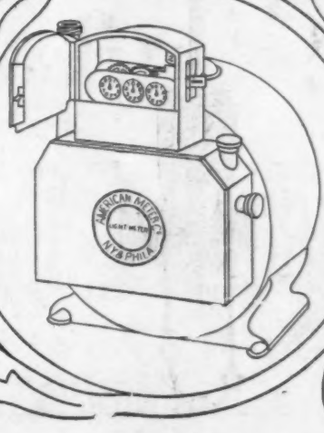
JANUARY, 1903.

DAY OF WEEK.	DATE.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Light.	Extinguish.
				P.M.	A.M.
Thu.	1	5.10 PM	6.20 AM	4.30	6.30
Fri.	2	5.10	6.20	4.30	6.30
Sat.	3	8.30	6.20	4.30	6.30
Sun.	4	9.30	6.20	4.30	6.30
Mon.	5	10.30	6.20	4.30	6.30
Tue.	6	11.40 FQ	6.20	4.30	6.30
Wed.	7	12.40 AM	6.20	4.30	6.30
Thu.	8	1.50	6.20	4.40	6.30
Fri.	9	2.50	6.20	4.40	6.30
Sat.	10	4.00	6.20	4.40	6.30
Sun.	11	5.00	6.20	4.40	6.30
Mon.	12	No L.	No L.	4.40	6.30
Tue.	13	No L. FM	No L.	4.40	6.30
Wed.	14	No L.	No L.	4.40	6.30
Thu.	15	5.30 PM	8.50 PM	4.50	6.25
Fri.	16	5.30	10.00	4.50	6.25
Sat.	17	5.30	11.10	4.50	6.25
Sun.	18	5.30	12.10 AM	4.50	6.25
Mon.	19	5.30	1.10	4.50	6.25
Tue.	20	5.30 LQ	2.10	4.50	6.25
Wed.	21	5.30	3.10	4.50	6.25
Thu.	22	5.30	4.10	5.00	6.25
Fri.	23	5.30	5.00	5.00	6.25
Sat.	24	5.30	5.50	5.00	6.25
Sun.	25	5.40	6.10	5.00	6.25
Mon.	26	5.40	6.10	5.00	6.25
Tue.	27	5.40	6.10	5.00	6.25
Wed.	28	5.40 NM	6.10	5.00	6.25
Thu.	29	5.40	6.10	5.05	6.15
Fri.	30	5.40	6.10	5.05	6.15
Sat.	31	5.40	6.10	5.05	6.15

TOTAL HOURS LIGHTING DURING 1903.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	245.00	January	423.20
February	192.00	February	355.25
March	201.00	March	355.35
April	167.20	April	298.50
May	152.00	May	264.50
June	131.00	June	234.25
July	140.40	July	243.45
August	156.20	August	280.25
September	171.20	September	321.15
October	198.20	October	374.30
November	216.30	November	401.40
December	232.10	December	433.45
Total, yr.	2203.40	Total, yr.	3987.45





NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

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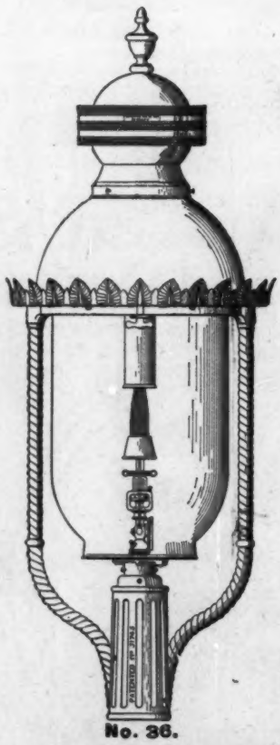

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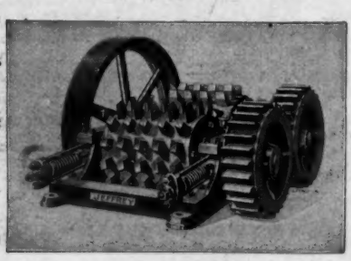

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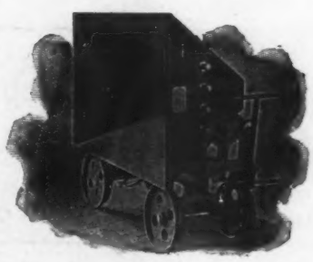

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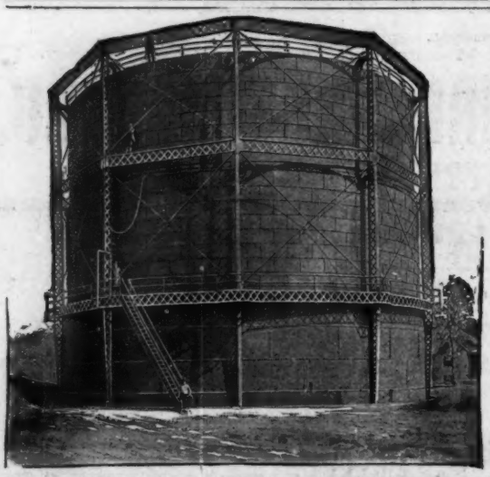

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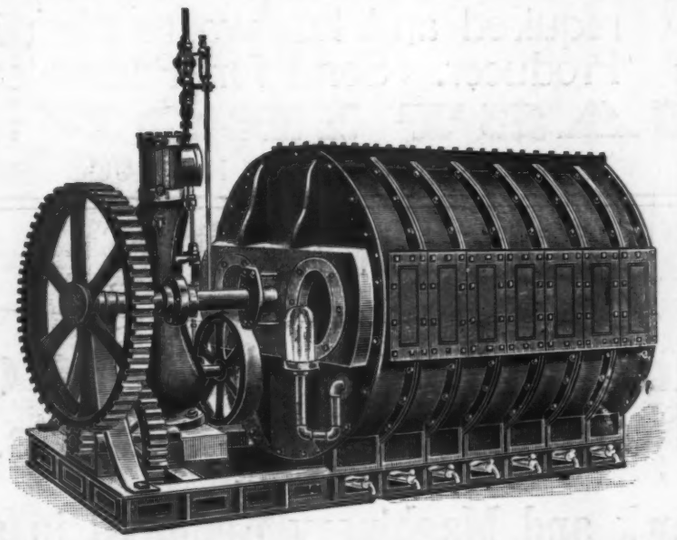

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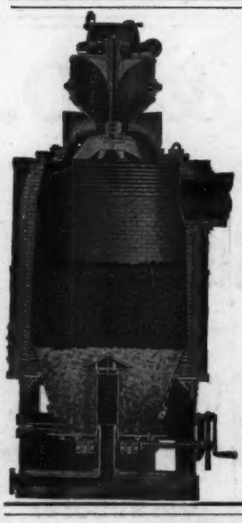

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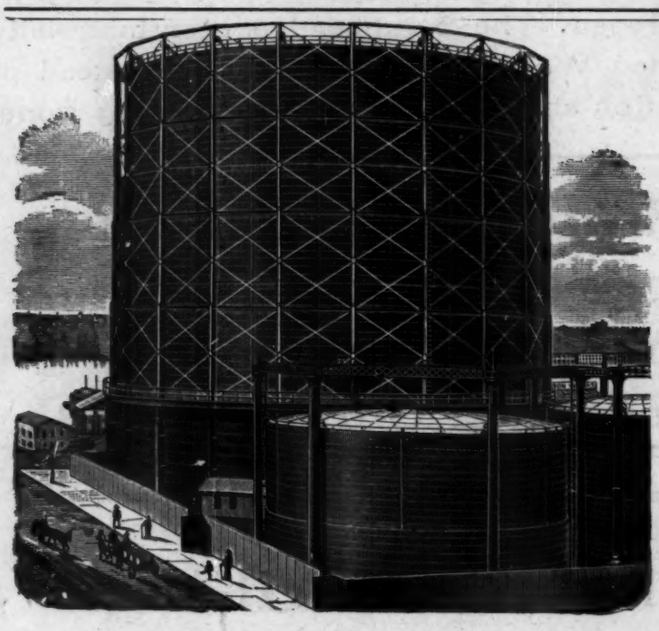

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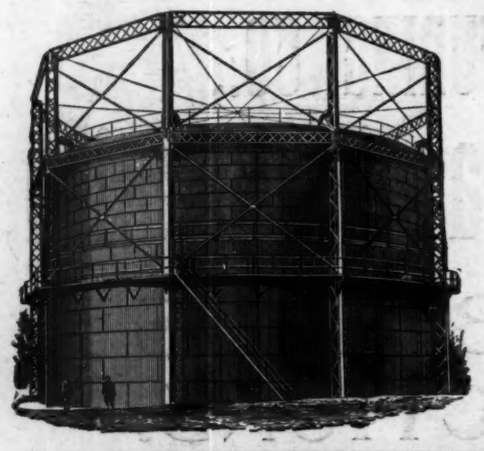

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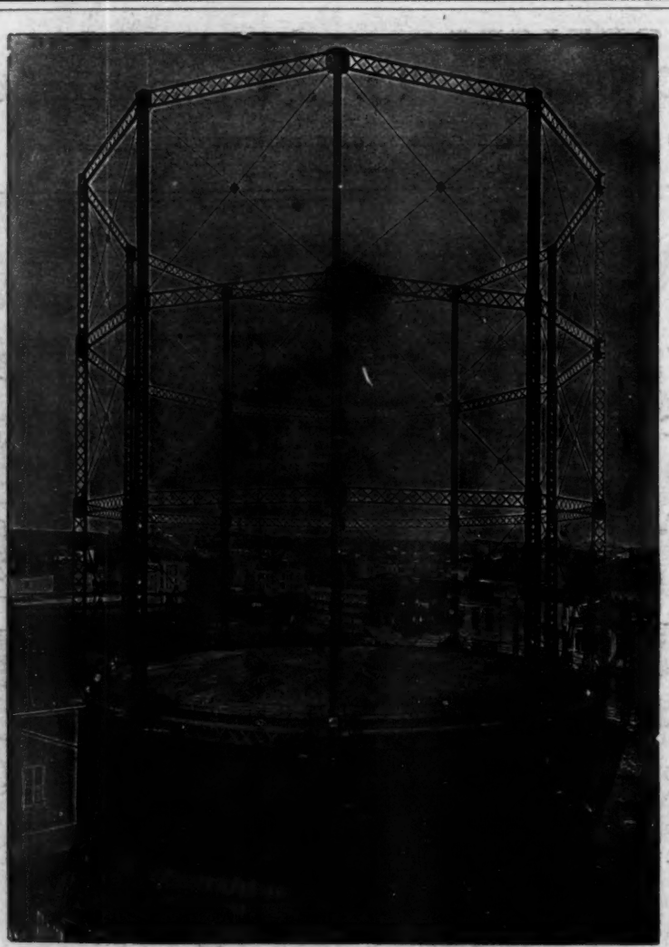

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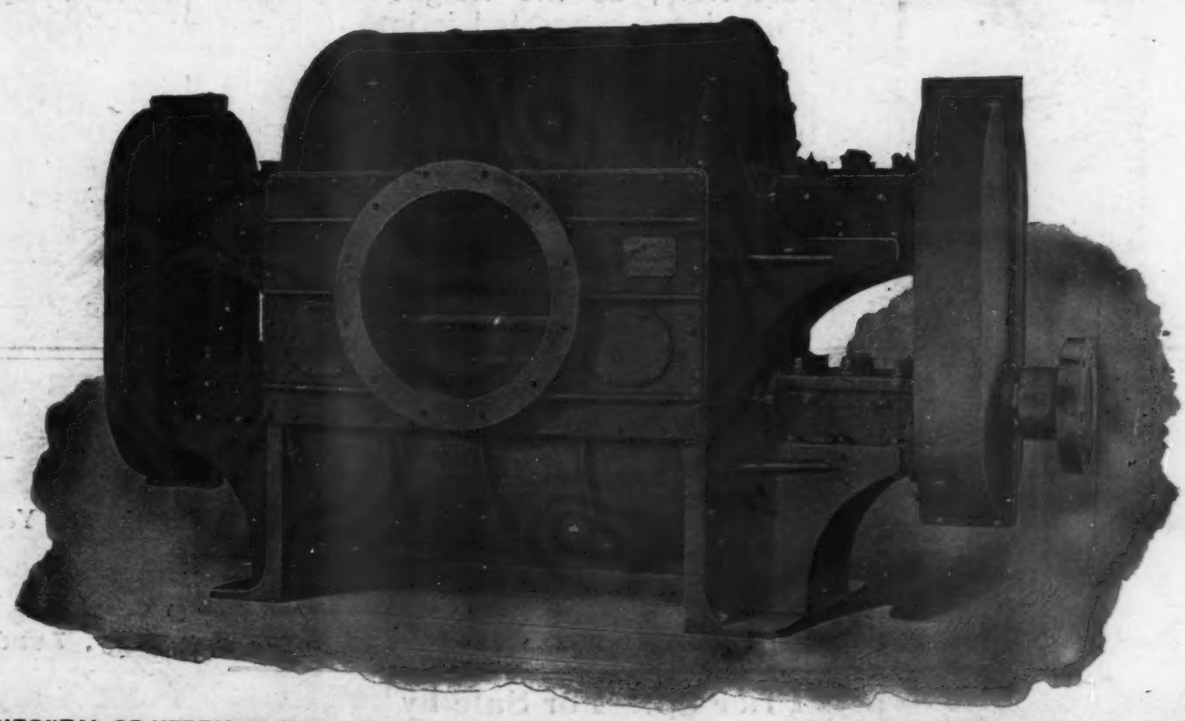

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